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COMPENSATING WAGE DIFFERENTIALS AND JOB RISK

by
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I. *Introduction*

The theory of wage differentials originated by Adam Smith suggests that workers employed in competitive labor markets and in jobs with undesirable characteristics should be paid more to be compensated for taking such jobs. Despite the fact that the theory of compensating differentials is almost two centuries old, only in the last fifteen years it has been subjected to successful empirical studies.

Some of these studies focus on the risk of death alone, others examine both the incidence of fatal and non-fatal injuries, some introduce only self-reported measures of job danger, while others introduce severity measures. However, to our knowledge, no study employs both detailed data on fatal and non-fatal injuries and self-reported employment characteristics with and without severity variables.

The purposes of this paper are threefold. First, to examine the effect of self-reported employment characteristics with and without fatal and non-fatal injuries on wage-risk premiums. The self-reported employment characteristics are grouped together using index-score technique analysis. Second, to investigate the wage-fatal and non-fatal risk relationship employing more detailed data on risk, occupational injuries and occupational illness. Third, to analyze the direct effect of severity on wage premiums by constructing an objective severity adjusted risk variable. The analysis is conducted with the aid of the *Quality of Employment Survey* (1977) data. The data represents a cross-sectional sample for the U.S.A. population and is supplemented with outside statistics to measure risk.

The structure of the paper is the following. Section II reviews the

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empirical findings of estimating procedures on compensating wage differentials. Section III describes the model specification, the data and the variables used in the empirical analysis. Section IV reports the empirical results. Section V concludes.

II. *Empirical Studies*

The theory of compensating wage differentials analyzes the relationship between wages and employment characteristics. The prediction of the theory is that, other things equal, wages will be higher in unpleasant or dangerous jobs.

Various studies have examined empirically the compensating wage differentials theory using different measures of risk. Negative employment characteristics can be classified as self-reported and fatalities directly related to occupational hazards. Self-assessed qualitative measures of job-danger include work place, physical and mental aspects of the job and so forth. Studies dealing with these characteristics have found mixed results. Lucas (1977), Duncan and Holmlund (1983) provide support for the argument that these characteristics affect workers' earnings. Contrary, the majority of these studies provides evidence that self-reported employment characteristics do not influence wages in a positive way as the theory predicts (Hamermesh, 1977; Smith, 1979; Brown, 1980; Meng, 1989).

Other studies have used more serious occupational hazards such as the risk of injury or death, or both, as measures of job risk (Table 1). Thaler and Rosen (1975), Smith (1979), Brown (1980), Marin and Psacharopoulos (1982), Dorsey (1983), Low and McPheters (1983), Duncan and Holmlund (1983), Leigh (1987), Moore and Viscusi (1988) employ risk of death data. Viscusi (1978), Viscusi and Moore (1987) use risk of injury data. Olson (1981), Cousineau et al. (1992) employ both risk of injury and death rates to derive the trade-off between risky occupations and wage rates. Arnould and Nichols (1983) use the actuarial risk of death by occupation class and assume that the probability of injury is proportional to the probability of death. The results that can be drawn from the studies that employ these characteristics are twofold. Studies using the "risk of death" variable find it to have a positive and statistically significant coefficient. Results with respect to the "risk of injury" variable are less clear cut but in most cases wage differentials exist for non-fatal risk. Cousineau et al. (1992) found positive significant coefficients on the fatal and non-fatal risk variables in the determination of wage risk premiums.

TABLE 1

DATA SET AND RISK VARIABLE SOURCE
USED IN WAGE DIFFERENTIALS STUDIES

Study	Data Set	Risk Variable
Thaler and Rosen (1975)[a]	Survey of Economic Opportunity, 1967	Actuarial-Thaler/Rosen
Smith (1976)[a]	Current Population Survey, 1973	Bureau of Labor Statistics (BLS), 1970
Viscusi (1978)[a]	Survey of Working Conditions (SWC), 1969-1970	BLS, 1969
Dillingham (1979)[a]	Census of Population, 1970	Constructed from U.S. Census and Worker's Compensation data, 1970
Brown (1980)[a]	National Longitudinal Survey, 1966-71, 1973	Actuarial-Thaler/Rosen
Olson (1981)[a]	Current Population Survey (CPS), 1973	BLS, 1973
Marin and Psacharopoulos (1982)[a]	General Household Survey, United Kingdom, 1975	British Office of Population Census and Surveys, 1970-72
Low and McPheters (1983)	International City Management Association 1976, City and Country Data Book, 1977	Department of Justice, 1972-75
Arnould and Nichols (1983)[a]	Census of Population, 1970	Actuarial-Thaler/Rosen
Dillingham (1985)	Quality of Employment Survey, QES, 1977	Constructed from U.S./ Census and Worker's Compensation
Viscusi and Moore (1987)	Quality of Employment Survey, 1977	BLS, 1979
Leigh (1987)	QES, 1977 and CPS, 1977	BLS, 1979
Moore and Viscusi (1988)	University of Michigan Panel Study of Income Dynamics (PSID), 1982	National Institute of Occupational Safety and Health (NIOSH), 1987
Meng (1989)	National Survey of Class Structure and Labour Process, 1981	Canadian Classification and Dictionary of Occupations Guide (CCDO), 1981 Labour Canada and Workman's Compensation Board, 1981
Cousineau, Lacroix and Girald (1992)	Annual Survey of Labour of Canada, 1979	Quebec Compensation Board and CCDO, 1971.

NOTES: [a] Data set and Risk Variable definitions are taken from Dillingham (1985).

Finally, other studies have introduced severity measures (Viscusi, 1978; Cousineau et al., 1992) which appear to play a significant role in the determination of wage compensating differentials.

III. *Model Specification*

Following other researchers (Viscusi, 1978; Brown, 1980; Meng, 1989) we formulate the equation of compensating wage differentials as follows:

$$\text{Ln } W = a + \sum_{k=1}^{n} B_k X_k + \sum_{j=1+n}^{m} B_j R_j + e \qquad (1)$$

where Ln W is the natural log of the hourly wage, X_k represents a series of human capital control variables (education, tenure, experience, vocational training) and personal characteristics variables (sex, race, marital status, health status). R_j are job-risk characteristics, subjective (self-assessed) and objective. The self-assessed variables are the physical effort required, the mental evaluation of the job, the friendly environment and the presence of dangerous substances and will be measured using the Z-score technique. The objective risk variables represent fatal, non-fatal injuries and severity measures, such as the death rate, the lost workday injury and illness rate and the average number of days per injury where at least one day was lost.

The semi-logarithm form estimated in the empirical analysis implies a rising supply price per characteristic unit. The regression equation will be estimated using the ordinary least squares (OLS) method as followed by various studies that test empirically the effect of risk variables on the wages received by workers.

IV. *The Data and the Variables*

The data employed to estimate the hedonic wage equation is the University of Michigan's *Quality of Employment Survey* (QES) for 1977. The 1977 QES summarizes the work experience of workers in 1976. The survey utilized a national probability sample of persons 16 years old or older who were working for pay for 20 or more hours per week. Although households were sampled at a constant rate, designated respondents had variable selection rates according to the number of eligible persons within a household. Therefore, each respondent was weighted by the number of persons in the

household. Information was obtained from a sample of 1,515 respondents in the form of 887 variables. The subsample we examined contains 804 observations. Self-employed were excluded from the subsample because for them there were not available death-risk data.

The 1977 QES is unique in the variety of individual-specific information provided about working conditions. The three-digit code, identifying the industry to which the worker's employer belonged made it possible to link the record for the worker to the Bureau of Labor Statistics data on workplace hazards. In the 1977 QES the hourly wage can be calculated unlike its antecedents, the 1972-1973 QES and the 1969-1970 Survey of Working Conditions.

TABLE 2

SAMPLE MEANS, STANDARD DEVIATIONS

Variable	Mean	Standard Deviation
WAGE	8.25	34.25
LWAGE	1.64	0.77
AGE	40.25	13.03
BLACK	0.10	0.30
FEMALE	0.36	0.48
ILLJOB	0.19	0.39
MARRIED	0.61	0.48
EXP	17.38	12.50
EDUC	12.87	3.06
TEN	6.41	6.41
VOCAT	0.37	0.89
UNION	0.33	0.47
SECUR	0.90	0.29
WKHOME	0.36	0.48
CITY	0.24	0.42
SOUTH	0.33	0.47
TOTDR	0.026	0.05
ILLDR	0.001	0.001
INJDR	0.025	0.05
TOTLWDI	8.73	5.45
ILLLWDI	0.27	0.25
INJLWDI	8.46	5.28

Table 2 presents the mean and the standard deviation of the dependent and independent variables. As independent variables we used a wide set of explanatory variables. Specifically, two kinds of job-risk variables are used: self-assessed and fatalities directly related to job hazards. The self-assessed

TABLE 3

(1977) QES PHYSICAL AND MENTAL EFFORT OF THE JOB VARIABLES

Symbol	Definition	Index Name
LEARN	Learn new things	CHARACT
FAST	Work very fast	
SKILL	High level of skill	
HARD	Work very hard	
CREATE	Work requires to be creative	
DIFF	Do different things	
SAY	Say a lot about what happens on my job	
SKILLS	Use my skills and abilities	
BREAKS	Decide about my breaks	
PROCED	Procedures for handling problems	
KNOW	Know what I have to do	
NOSATIS	Can not satisfy everybody	
SPEED	Determine speed of work	
KNOWEXP	Know what expected of me	
REPET	Do things over and over	

TABLE 4

(1977) QES MENTAL EVALUATION OF THE JOB VARIABLES

Symbol	Definition	Index Name
HARDQT	Difficult to leave my job even if I want to	EVALUATE
NOTIME	No enough time	
AFRQT	Afraid if leave my job without having another	
IMPACT	Impact of my work on product or service	
MONEY	My main interest is to get money from my job	
MEANING	The work on my job is meaningful	
ENERGY	Energy left after work	
DESERVE	Deserve blame or credit for how I do my job	
RULES	Rules on what I have to do on my job	

variables are constructed from a set of detailed variables indicating subjective evaluation of the job. First, a subset of variables (Table 3) indicating physical and mental effort required on the job creates the variable CHARACT. Second, another subset (Table 4) identifying mental evaluation of the job constructs the variable EVALUATE. Third, Table 5 presents a subset of vari-

TABLE 5

QES (1977) FRIENDLY AND SUPPORTIVE WORK ENVIRONMENT VARIABLES

Variable	Definition	Index Name
FRIEND	Chances to make friends	SUPPORT
PLEASNT	Physical surroundings are pleasant	
SEERESLT	See results of my work	
FORGET	Forget personal problems	
TIME	Enough time to do the job	
NODEMD	Free of conflicting demands	
HOURGD	Hours are good	
PERSINT	Coworkers care about me	
COWHELP	Coworkers helpful	
COWCOMP	Coworkers competent in doing job	
COWFRND	Coworkers friendly	

TABLE 6

QES (1977) UNHEALTHY AND DANGEROUS SUBSTANCES VARIABLES

Variable	Definition	Index Name
	Your job exposes you to:	
JCHEM	Chemicals?	SUBSTAN
JFIRE	Danger from fire?	
JPOLL	Air pollution?	
JWEATH	Working in bad weather?	
JTEMP	Extremes of temperature?	
JDIRT	Dirt?	
JDANG	Dangerous things?	
JNOISE	Noise?	
JTOOL	Dangerous tools?	
JDIS	Risk of catching disease?	
JTRACC	Risk of traffic?	
JATT	Risk of personal attack?	
JWRK	Dangerous work methods?	

ables specifying the friendly and supportive work environment that create the variable SUPPORT. Finally, in Table 6 variables showing the presence of unhealthy dangerous substances create the variable SUBSTAN (see appendix).

The variables used to create the new generated variables (CHARACT, EVALUATE, SUPPORT, SUBSTAN) have multiple heterogenous responses. Therefore it was necessary to transform them and construct a homogenous index. For this reason the Z-score technique was employed. The Z-score variable transformation standardizes variables with different observed scales to the same scale. The new generated variables have a mean of zero and standard deviation of one. The new generated variables were then added and new index variables were created one for each of the four categories generated. The Z-score technique is preferred to other similar techniques (principal component) for two reasons. First, it forces the variables to have the same weight. Second, it provides a single index-variable for each category of workers' characteristics.

Thus using the Z-score technique transformation we construct four indices. The first index, CHARACT, indicates characteristics of the job that require physical or mental effort. The second index, EVALUATE, shows the worker's mental evaluation of the job. The third index, SUPPORT, indicates a friendly and supportive work environment. Finally, the fourth index indicates the presence of unhealthy and dangerous substances, such as chemicals, noise, dust.

There are characteristics for which we did not apply the Z-score technique because these variables are not correlated with any of the variables included in the Z-score grouping. These are the dummy variables: SECUR, that takes the value of 1 if the employee thinks his job as secure; WKHOME, that takes the value of 1 if the worker has to work at home as part of his job; SAMDAYS, that takes the value of 1 if the worker works the same days every week.

The problem with such self-assessed variables is that they may suffer from lack of comparability across workers. That is, workers may under-or-over report their employment characteristics according to their preferences towards that characteristic. Workers that are averse toward a particular job characteristic may choose jobs that primarily lack this unpleasant characteristic. These workers may over-report its presence relative to workers that are less-averse to this particular characteristic. Therefore, workers that are exposed more to a particular characteristic under-report it and workers who are exposed less to a characteristic over-report it. Such an under-over reporting may result to a variable that does not fully reflect differences on

severity and cannot be used as a measure of comparability across individuals.

Objective risk variables directly related to occupational hazards are employed. They are based on the U.S. Bureau of Labor Statistics 1977 (BLS) data on industrial injuries and illness and are matched to workers in the QES by three-digit industry code. The variables are: TOTDR and TOTLWDI. The TOTDR variable represents the number of fatalities and the TOTLWDI the number of lost workdays cases of illness and injuries per 100 full-time workers. The IILDR and INJDR variables represent the number of fatalities resulting from illness and injuries respectively. The ILLLWDI and INJLWDI are the number of lost workdays resulting from an illness and injury. Respectively, the occurrence data, TOTDR, implies that 2.6 out of 1,000,000 workers die from a job accident. More specifically 2.5 die from an injury accident (INJDR) and 0.01 from an illness accident (ILLDR). The severity figure, (TOTLWDI) shows that there are 8.73 lost workday injuries per year among 100 full-time workers. Of this, 8.46 days are due to an injury (INJLWDI) and 0.27 are due to an occupational illness (ILLLWDI). The TOTSEV variable represents the average number of days per injury where at least one day was lost.

Besides the objective and subjective risk variables, other explanatory variables are included as regressors to control for the wage variation: personal characteristics variables; FEMALE, sex dummy variable that takes the value of 1 if the respondent is female; BLACK, race dummy variable that takes the value of 1 if black; MARRIED, dummy variable that takes the value of 1 if spouse is present in the household; ILLJOB, dummy variable, refers to the severity of health limitation and takes the value of 1 if respondent had within the last three years any illness or injuries that were caused or made more severe by any job that he had during that period; human capital variables; EDUC continuous variable, that shows the years of formal education of the respondent; EXP, continuous variable, that reports years worked since age 16; TEN, continuous variable, that reports the years the respondent has worked with current employer; VOCAT, continuous variable, that reports the years of training or vocational school the worker has completed; UNION, dummy variable, whether the worker reports that he belongs or has a contract with a union or employees' association; SOUTH dummy variable, if respondent lives in the South; CITY, dummy variable, if he lives in an urban area. Finally, occupation dummy variables that are reported in Table 7 (PROF, MANG, SALES, CLER, CRAFT, OPER and LAB) are entered to control for occupation specific characteristics that are not measured by the rest of the control variables. The dependent variable in the subsequent analysis is the natural logarithm of the workers' hourly wage.

TABLE 7

DESCRIPTION OF VARIABLES

Variable	Operational Definition
LWAGE	Logarithm of hourly wage.
FEMALE	Sex dummy variable (d.v.): 1 if female, 0 otherwise.
BLACK	Race dummy variable (d.v.): 1 if black, 0 otherwise.
MARRIED	Marital status (d.v.): 1 if married, including living with spouse, 0 if unmarried, including widowed and divorced.
ILLJOB	Health status (d.v.): 1 if respondent reports bad health that was caused or made more severe by any job he had during that period, 0 otherwise.
EDUC	Years of formal education.
EXP	Experience variable: Worker employed since the age of 16.
EXP2	Experience variable squared
TEN	Years with current job.
VOCAT	Years of vocational or technical training.
SECUR	Job security (d.v.): 1 if worker feels that his job is secure, 0 otherwise.
WKHOME	Working at home as part of his job dummy variable (d.v.): 1 if worker works at home for his company, 0 otherwise.
SAMDAYS	Working the same days every week dummy variable (d.v.): 1 if worker works the same days every week, 0 otherwise.
UNION	Union dummy variable (d.v.): 1 if the worker belongs or has a contract with a union or to an employees' association, 0 otherwise.
CHARACT	Index-score transformed variable: work requires mental or physical effort.
EVALUATE	Index-score transformed variable: mental evaluation of the job.
SUPPORT	Index-score transformed variable: work in a friendly and supportive environment.
SUBSTAN	Index-score transformed variable: work in hazardous substances.
TOTDR	BLS industry hazard variable: death rate.
TOTLWDI	BLS industry hazard variable: lost workday injury and illness rate.
ILLDR	BLS industry hazard variable: death rate resulting from illness.
INJDR	BLS industry hazard variable: death rate resulting from injury.
ILLLWDI	BLS industry hazard variable: lost workday illness rate.
INJLWDI	BLS industry hazard variable: lost workday injury rate.
TOTSEV	BLS industry hazard variable: average number of days per injury where at least one day was lost.
CITY	Urban area dummy variable (d.v.): 1 if worker lives in an urban area, 0 otherwise.
SOUTH	South region dummy variable (d.v.): 1 if the worker lives in the south, 0 otherwise.
PROF	Professional and Technical (d.v.): 1 if the worker reports occupation as professional, 0 otherwise.
MANG	Manager and administrator (d.v.): 1 if worker reports occupation as manager or administrator, 0 otherwise.
SALES	Sales (d.v.): 1 if worker reports occupation as sales, 0 otherwise.
CRAFT	Craftsman (d.v.): 1 if worker reports occupation as craftsman or foreman, 0 otherwise.
OPER	Operative (d.v.): 1 if worker reports occupation as non-transport-operative, 0 otherwise.
LAB	Unskilled laborer (d.v.): 1 of worker reports occupation as unskilled laborer, 0 otherwise.
SERV	Service (d.v.): 1 if worker reports occupation as private household services, 0 otherwise.

IV. *Empirical Results*

a - *Self-assessed Risk Measures.* – In the empirical analysis we estimate equation (1) of Section III. Table 8 presents the empirical results from the regression equation using self-assessed risk variables. In the estimation procedure we employ the method of ordinary least squares (OLS). Model A1 is the traditional human capital model. The most of the estimated regression coefficients are statistically significant indicating differences in the wage determination due to sex, health status, marital status, education tenure, experience, if the worker leaves in a city and he belongs to a union. The value of R-square is 22% which is considered a good fit for a cross-section data. The value of F-statistic is 17.25 indicating the good fit of the model. Specifically, the estimated value of F-test can not reject the null hypothesis that jointly all the estimated coefficients are not equal to zero ($P = 0.0001$). Similar in magnitude values of the F-test are reported in the subsequent analysis supporting the evidence of good fit of the estimated models.

Models A2 and A3 introduce the employment characteristics variables. More specifically, in model A2 the Z-score transformed variables are introduced along with the human capital model. Of the new variables added only the estimated coefficient for the physical and mental effort (CHARACT) is statistically significant. The statistically significant positive coefficient indicates that unpleasant characteristics such as physical and mental effort on the job require extra compensation. In model A3 the subjective risk variables that were not subject to Z-score transformation are entered. All the estimated coefficients for the new variables are statistically significant. The positive sign for the first two variables, SECUR (whether the worker feels that his job is secure), WKHOME (if the worker works extra at home for his company) indicate that increased security for his job and additional work at home for his job generate additional payment for him. The negative sign for the variable SAMDAYS (working the same days every week) shows that regular work hours make the worker feel that he has a scheduled well-organized work plan so he does not ask for extra compensation. In model A4 all the subjective risk variables, whether subject to Z-transformation or not, are introduced in the analysis. The addition of the new variables does not alter the sign of the estimated coefficients, only the coefficient of the variable CHARACT is statistically significant at $P = 15\%$.

Model A5 includes seven occupational dummy variables to control for unobservable occupation-specific characteristics. The omitted category is services. The estimated coefficients of the regressors do not alter compared to

TABLE 8
REGRESSION ESTIMATES OF WAGE-RISK PREMIA: SUBJECTIVE RISK MEASURES
[DEPENDENT VARIABLE: LN (WAGE)]

	ESTIMATED COEFFICIENTS				
VARIABLES	MODEL A1	MODEL A2	MODEL A3	MODEL A4	MODEL A5
INTERCEP	0.5408681	0.605708	0.53151	0.5908	0.5860
	(3.794)	(4.121)	(3.102)	(3.337)	(3.064)
FEMALE	–0.31395	–0.31030	–0.3225	–0.3196	–0.2987
	(–5.649)	(–5.378)	(–5.829)	(–5.54)	(–4.856)
BLACK	–0.07267	–0.054673	–0.0413	–0.0315	–0.0296
	(–0.897)	(–0.675)	(–0.511)	(–0.388)	(–0.365)
ILLJOB	–0.11509	–0.09863	–0.1159	–0.1031	–0.1081
	(–1.812)	(–1.473)	(–1.826)	(–1.544)	(–1.616)
MARRIED	0.080255	0.08194	0.0769	0.079	0.0688
	(1.419)	(1.448)	(1.366)	(1.399)	(1.212)
EDUC	0.048600	0.04544	0.04217	0.04133	0.0320
	(5.768)	(5.160)	(4.656)	(4.441)	(3.105)
TEN	0.052204	0.04897	0.0488	0.04727	0.0446
	(3.481)	(3.265)	(3.247)	(3.137)	(2.955)
TEN 2	–0.19854	–0.00184	–0.00188	–0.00181	–0.00177
	(–2.592)	(–2.411)	(–2.458)	(–2.358)	(–2.308)
EXP	0.035965	0.03438	0.0347	0.0339	0.0321
	(4.596)	(4.394)	(4.434)	(4.316)	(4.105)
EXP 2	–0.00067	–0.00064	–0.00064	–0.00063	–0.00059
	(–4.131)	(–3.981)	(–3.928)	–(3.858)	(–3.675)
VOCAT	–0.02066	–0.02102	–0.01549	–0.0164	–0.0187
	(–0.744)	(–0.754)	(–0.559)	(–0.591)	(–0.670)
UNION	0.21079	0.21769	0.22139	0.2252	0.2195
	(3.835)	(3.914)	(4.038)	(4.051)	(3.883)
SECUR			0.1930	0.1612	0.1441
			(2.354)	(1.909)	(1.714)
WKHOME			0.0999	0.07356	0.0494
			(1.758)	(1.262)	0.804
SAMDAYS			–0.1223	–0.1174	–0.1719
			(–1.793)	(–1.694)	(–2.408)

Note: t–statistics in brackets

(*continued*) TABLE 8

	ESTIMATED COEFFICIENTS				
VARIABLES	MODEL A1	MODEL A2	MODEL A3	MODEL A4	MODEL A5
CHARACT		0.00860		0.00692	0.00548
		(2.023)		(1.593)	(1.237)
EVALUAT		0.0022		0.00222	0.00172
		(0.310)		(0.314)	(0.244)
SUPPORT		0.00497		0.00335	0.00492
		(1.193)		(0.791)	(1.163)
SUBSTAN		0.00116		0.000436	0.00224
		(0.297)		(0.110)	(0.537)
CITY	0.094778	0.08541	0.0939	0.0869	0.068
	(1.608)	(1.450)	(1.602)	(1.480)	(1.158)
SOUTH	0.009966	−0.0089	0.01286	−0.0027	−0.0166
	(0.182)	(−0.164)	(0.237)	(−0.050)	(−0.304)
PROF					0.3248
					(3.120)
MANG					0.3338
					(2.992)
SALES					0.0311
					(0.213)
CLER					0.2879
					(2.992)
CRAFT					0.2767
					(2.727)
OPER					0.2384
					(2.486)
LAB					0.0544
					(0.389)
R-SQUARE	0.2211	0.2297	0.2328	0.2376	0.2548
F	17.251	13.788	14.922	12.202	9.827
	0.0001	0.0001	0.0001	0.0001	0.0001

Note: t-statistics in brackets

TABLE 9
REGRESSION ESTIMATES OF WAGE-RISK PREMIA: OBJECTIVE RISK MEASURES
[DEPENDENT VARIABLE: LN (WAGE)]

	ESTIMATED COEFFICIENTS			
VARIABLES	MODEL: A6	MODEL: A7	MODEL: A8	MODEL: A9
INTERCEP	0.416767	0.47518	0.466155	0.48053550
	(2.205)	(2.419)	(2.366)	(2.454)
FEMALE	−0.28108	−0.27760	−0.2725	−0.283145
	(−4.689)	(−4.447)	(−4.326)	(−4.551)
BLACK	−0.025492	−0.02757	−0.02695	−0.0282488
	(−0.314)	(−0.339)	(−0.332)	(−0.348)
ILLJOB	−0.096888	−0.10190	−0.1021	−0.105965
	(−1.454)	(−1.524)	(−1.527)	(−1.585)
MARRIED	0.077654	0.069188	0.069301	0.06876086
	(1.379)	(1.220)	(1.222)	(1.213)
EDUC	0.045961	0.03457	0.03517	0.03473853
	(4.860)	(3.333)	(3.375)	(3.347)
TEN	0.04636	0.043398	0.043516	0.0443366
	(3.087)	(2.880)	(2.887)	(2.944)
TEN 2	−0.001778	−0.001719	−0.001717	−0.00175975
	(−2.322)	(−2.246)	(−2.242)	(−2.299)
EXP	0.033703	0.031753	0.031690	0.03198868
	(4.299)	(4.056)	(4.046)	(4.087)
EXP2	−0.0006265	−0.0005927	−0.0005929	−0.000598638
	(−3.839)	(−3.645)	(−3.645)	(−3.683)
VOCAT	−0.01312	−0.01386	−0.01391	−0.0152319
	(−0.471)	(−0.495)	(−0.497)	(−0.544)
UNION	0.216424	0.216077	0.219398	0.21210490
	(3.897)	(3.829)	(3.869)	(3.754)
CITY	0.081837	0.060754	0.060206	0.06282634
	(1.391)	(1.032)	(1.022)	(1.068)
SOUTH	−0.004400	−0.01814	−0.01951	−0.0179286
	(−0.080)	(−0.331)	(−0.356)	(−0.327)
WKHOME	0.086565	0.050326	0.048329	0.05243364
	(1.484)	(0.821)	(0.787)	(0.855)
SECUR	0.161424	0.144142	0.143320	0.14357703
	(1.916)	(1.717)	(1.706)	(1.710)
SAMDAYS	−0.12889	−0.1689	−0.1693	−0.168884
	(−1.860)	(−2.372)	(−2.376)	(−2.370)
CHARACTER	0.0074480	0.0059704	0.0060476	0.006113916
	(1.710)	(1.345)	(1.361)	(1.376)

Note: t-statistics in brackets

(*continued*) TABLE 9

	ESTIMATED COEFFICIENTS			
VARIABLES	MODEL: A6	MODEL: A7	MODEL: A8	MODEL: A9
EVALUATE	0.0022119	0.0014498	0.0014019	0.001457844
	(0.313)	(0.205)	(0.199)	(0.207)
SUPPORT	0.003054	0.004624	0.0046481	0.004504092
	(0.723)	(1.094)	(1.100)	(1.066)
SUBSTAN	–0.001551	0.0010904	0.00084775	0.001004871
	(–0.383)	(0.257)	(0.199)	(0.237)
PROF		0.319160	0.313336	0.31358481
		(3.064)	(2.995)	(3.010)
MANG		0.300293	0.295953	0.29497448
		(2.665)	(2.620)	(2.613)
SALES		–.00008144	–0.006295	0.005155118
		(–0.001)	(–0.043)	(0.035)
CLER		0.266428	0.257673	0.26942368
		(2.753)	(2.634)	(2.787)
CRAFT		0.207193	0.195615	0.21067504
		(1.950)	(1.812)	(1.990)
OPER		0.182605	0.176878	0.18329513
		(1.851)	(1.784)	(1.860)
LAB		–0.0272	–0.03417	–0.0132321
		(–0.188)	(–0.234)	(–0.092)
TOTDR	0.135165	0.044028	1.021908	–0.287946
	(0.248)	(0.080)	(0.611)	(–0.480)
TOTLWDI	0.012460	0.01250	0.011989	
	(2.393)	(2.300)	(2.178)	
TOTDR2			–4.312	
			(–0.619)	
ADJSEV				0.0007706156
				(2.325)
R-SQUARE	0.2441	0.2603	0.2606	0.2604
F-STATISTIC	11.464	9.39	9.083	9.395
	0.0001	0.0001	0.0001	0.0001

Note: t-statistics in brackets

model A4. The estimated coefficients for the occupational variables have positive sign and are statistically significant except for SALES and LAB. The statistically significant signs indicate that all different occupations require extra compensation relative to services. We performed F-test to see whether the group of variables added to the unrestricted human capital model helps explain the variation in the dependent variable. All of the tests performed indicate that these variables are significant determinants of wages, as predicted by the theory.

b - *Fatalities Directly Related to Occupational Hazards.* – Table 9 reports analytical regression results when objective risk variables are entered additionally to the subjective risk variables. Model A6 introduces the two objective measures: accident rate and death rate. Model A7 controls for occupational variation and model A8 allows for nonlinearities of the risk measures. Whether we control for occupational variation or not and we allow for non-linearities, the estimated coefficients of the risk variables, TOTDR and TOTLWDI, are always positively signed. Only the measure of injuries is statistically significant, the measure of deaths is insignificant. The sign of the risk squared variable (TOTDR 2) is negative but not statistically significant.

Model A9 of Table 9 reports regression results when the death rate and a severity adjusted rate are included as regressors. We constructed a severity-adjusted measure that was defined as the product of the two injury risk variables (ADJSEV): the average number of days per injury where at least one day was lost (TOTSEV) and the lost workday injury and illness rate (TOTLWDI). The constructed severity variable is an approximation of the expected severity. The wage determination will be influenced not only on the probability, but also on the expected severity of accidents (Viscusi, 1978). The estimated coefficient on the death rate (TOTDR) is negative and insignificant and the coefficient on the severity adjusted measure (ADJSEV) is positive and significant. The coefficient on the severity adjusted variable is the smallest in magnitude compared to the other risk coefficients. Workers receive wage premia for increases in the severity of an accident, but these wage premia are smaller in magnitude than the wage premia generated from the risk of injury. The differences in the magnitude of the risk coefficients stems from the fact that the measures of the risk variables are different.

Table 9a focuses on the coefficients of the risk variables separately and jointly when human capital, employment characteristics and occupational variables are present (model A7). When the risk variables TOTDR and TOTLWDI are analyzed alone, each risk measure has a positive coefficient. Only the measure of injuries is statistically significant, the measure of deaths

TABLE 9A
WAGE-RISK COEFFICIENTS BASED ON MODEL A7 OF TABLE 9

VARIABLES	MODEL:1	MODEL:2	MODEL:3	MODEL:4	MODEL:5	MODEL:6
TOTDR	0.349906			0.044028		0.09399604
	(0.653)			(0.080)		(0.144)
TOTLWDI		0.0126114		0.01250	0.0126643	0.01250293
		(2.392)		(2.300)	(2.380)	(2.298)
TOTSEV			0.0020856		-0.0006955	-.00152861
			(0.231)		(-0.077)	(-0.142)
R-SQUARE	0.2552	0.2603	0.2548	0.2603	0.2603	0.2603
F-STATISTIC	9.484	9.738	9.466	9.39	9.390	9.066
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Note: t-statistics in brackets

is insignificant. The results do not alter when we introduce both measures. Whether we control for occupational variation or not the evidence is that injury and the probability of having a fatal accident do not produce the same compensating wage differentials. The coefficient on injury is significant and positive in both models. The coefficient of fatality is insignificant in both models. Accidents that result in lost workdays result in wage premia. The positive coefficient on TOTLWDI supports the hypothesis that wages respond positively to increases in injury rates. The insignificance of the TOTDR coefficient does not allow us to make any conclusions about wage premia or wage discounts from fatal accident rates.

Another dimension of injury rates was available: the average number of days per injury where at least one day was lost, is presented by the variable TOTSEV. The coefficient on the severity measure when analyzed alone is positive and insignificant. When the two injury rates are introduced together the severity measure loses its positive sign but remains insignificant. When all three risk variables are included the coefficient on the measure of death is insignificant but positive and the measure of injury is significant and positive. The measure of severity is negative but insignificant. Multicollinearity might have caused such an unexpected coefficient.

The value of R-square, which explains the variation of the dependent variable due to the variation of independent variables, in most of the models is less than 30 which is considered adequate for cross-section data [1].

[1] Researchers (MOORE and VISCUSI, 1988) report small R-square values for similar type of analysis.

c - *Injury - Illness Risk Effects on Wages.* – Regression results using two sources of risk, occupational illness and occupational injuries are presented in Table 10. Examination of the coefficient estimates of the variable INJDR, when regressed alone (model E1) shows that it is insignificant. The esti-

TABLE 10

ILLNESS-INJURY ACCIDENT WAGE DIFFERENTIALS
[DEPENDENT VARIABLE: LN (WAGE)]

	ESTIMATED COEFFICENTS					
VARIABLES	MODEL: E1	MODEL: E11	MODEL: E2	MODEL: E3	MODEL: E4	MODEL: E44
INTERCEP	0.57535	0.473722	0.578106	0.473519	0.570472	0.565120
	(2.993)	(2.410)	(3.030)	(2.412)	(2.978)	(2.957)
FEMALE	–0.29347	–0.2775	–0.28661	–0.27739	–0.3005	–0.2886
	(–4.715)	(–4.446)	(–4.653)	(–4.476)	(–4.886)	(–4.684)
BLACK	–0.02700	–0.02786	–0.026762	–0.027735	–0.031542	–0.028516
	(–0.331)	(–0.343)	(–0.330)	(–0.342)	(–0.388)	(–0.352)
ILLJOB	–0.10648	–0.1023	–0.11467	–0.102298	–0.104194	–0.11100
	(–1.588)	(–1.531)	(–1.716)	(–1.532)	(–1.555)	(–1.659)
MARRIED	0.06867	0.069452	0.070446	0.069440	0.066533	0.068373
	(1.208)	(1.225)	(1.243)	(1.226)	(1.171)	(1.206)
EDUC	0.03255	0.034626	0.032498	0.034642	0.031761	0.032217
	(3.140)	(3.337)	(3.154)	(3.347)	(3.076)	(3.127)
TEN	0.04448	0.043409	0.044041	0.043407	0.044225	0.043740
	(2.946)	(2.881)	(2.925)	(2.883)	(2.930)	(2.904)
TEN 2	–0.0017	–0.001719	–0.001719	–0.001719	–0.001772	–0.001722
	(–2.293)	(–2.246)	(–2.246)	(–2.247)	(–2.311)	(–2.250)
EXP	0.03232	0.031794	0.031586	0.031802	0.031416	0.030951
	(4.119)	(4.061)	(4.036)	(4.068)	(3.996)	(3.945)
EXP2	–0.00060	–0.000593	–0.0005978	–0.0005935	–0.0005851	–0.0005864
	(–3.688)	(–3.650)	(–3.680)	(–3.655)	(–3.586)	(–3.603)
VOCAT	–0.01730	–0.01398	–0.02091	–0.013925	–0.01806	–0.020265
	(–0.617)	(–0.499)	(–0.750)	(–0.499)	(–0.647)	(–0.727)
UNION	0.21940	0.216283	0.227846	0.216285	0.216019	0.22446
	(3.878)	(3.833)	(4.031)	(3.835)	(3.817)	(3.965)
CITY	0.07011	0.060464	0.064074	0.060593	0.063589	0.060417
	(1.191)	(1.027)	(1.093)	(1.033)	(1.081)	(1.029)
SOUTH	–0.019088	–0.01787	–0.01629	–0.017998	–0.014637	–0.0145924
	(–0.347)	(–0.326)	(–0.298)	(–0.330)	(–0.267)	(–0.267)
WKHOME	0.049495	0.050155	0.039981	0.0501554	0.051873	0.042453
	(0.805)	(0.818)	(0.650)	(0.818)	(0.844)	(0.690)
SECUR	0.14322	0.143819	0.139022	0.143773	0.149582	0.143877
	(1.701)	(1.713)	(1.656)	(1.714)	(1.776)	(1.712)
SAMDAYS	–0.17185	–0.16918	–0.1815	–0.16919	–0.1692	–0.1787
	(–2.405)	(–2.374)	(–2.544)	(–2.376)	(–2.369)	(–2.504)
CHARACT	0.005332	0.0059852	0.0054572	0.0059761	0.0058592	0.0057799
	(1.200)	(1.348)	(1.234)	(1.351)	(1.319)	(1.304)
EVALUATE	0.001940	0.0014784	0.00072594	0.0014899	0.00088154	0.000044064

Note:t–statistics in brackets
Death rates per 1,000,000 full time workers

(*continued*) TABLE 10

	ESTIMATED COEFFICENTS					
VARIABLES	MODEL: E1	MODEL: E11	MODEL: E2	MODEL: E3	MODEL: E4	MODEL: E44
	(0.274)	(0.210)	(0.103)	(0.212)	(0.124)	(0.006)
SUPPORT	0.004836	0.0046230	0.0053467	0.0046196	0.004953	0.0053574
	(1.142)	(1.094)	(1.265)	(1.095)	(1.171)	(1.268)
SUBSTAN	0.001823	0.0011491	0.0026067	0.0011312	0.0019834	0.0023672
	(0.429)	(0.271)	(0.625)	(0.270)	(0.474)	(0.567)
PROF	0.320368	0.320433	0.320501	0.320223	0.318061	0.314901
	(3.067)	(3.077)	(3.086)	(3.085)	(3.062)	(3.029)
MANG	0.325982	0.300870	0.328566	0.300574	0.327396	0.32328
	(2.898)	(2.670)	(2.952)	(2.681)	(2.932)	(2.902)
SALES	0.027703	-0.001613	0.020107	-0.001691	0.034483	0.023383,
	(0.189)	(-0.011)	(0.137)	(-0.012)	(0.235)	(0.160)
CLER	0.282346	0.267221	0.259384	0.267002	0.282360	0.255784
	(2.917)	(2.763)	(2.679)	(2.771)	(2.932)	(2.640)
CRAFT	0.266379	0.208198	0.2579225	0.2078818	0.254866	0.239967
	(2.573)	(1.960)	(2.530)	(1.970)	(2.468)	(2.324)
OPER	0.231970	0.183402	0.229417	0.1832387	0.216581	0.211015
	(2.400)	(1.860)	(2.395)	(1.863)	(2.223)	(2.170)
LAB	0.037676	-0.024685	0.016906	-0.025290	0.026161	-0.005747
	(0.263)	(-0.170)	(0.120)	(-0.176)	(0.185)	(-0.040)
INJDR	.00003036	-.00000152				
	(0.567)	(-0.028)				
INJLWDI		0.0131027		0.0130640		
		(2.328)		(2.398)		
ILLDR			0.0031194			0.111535
			(2.236)			(1.089)
ILLLWDI					0.130150	0.0029896
					(1.272)	(2.136)
R-SQUARE	0.2551	0.2603	0.2596	0.2603	0.2563	0.2607
F-STATISTIC	9.479	9.391	9.703	9.739	9.541	9.412
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Note:t-statistics in brackets
Death rates per 1,000,000 full time workers

mated coefficient for the variable ILLDR is positive and statistically significant (model E2). This result shows that positive wage differentials are paid for increases in the risk of dying from an occupational illness. Examination of the coefficient estimates of the variables INJLWDI (model E3) and ILLLWDI (model E4) shows that they are both positive but only the INJLWDI is significant. Therefore, positive wage differentials are paid for increases in the lost workdays due to injury (INJLWDI).

When we use both measures of illnesses and injuries (model E11 and model E44) a clear pattern emerges. The estimated coefficients show a positive effect of injuries on wages and an insignificant result of fatalities on wages. Lost workdays due either to occupational illnesses or occupational

injuries create positive compensating wage differentials. On the other hand, there is no evidence that death rates, due to illness or injuries, create wage premia.

In conclusion, there is evidence that workers are compensated for the risk of experiencing a nonfatal accident that results in lost workdays from an occupational illness or an occupational injury.

V. *Conclusion*

The main hypothesis that was verified is that individuals in hazardous jobs receive risk premiums to be compensated for work-related accidents. We examined the effect of subjective and objective evaluation of risk on wage-risk premiums. The subjective employment characteristics were subject to index-score analysis. Four index transformed variables were constructed using the Z-score transformation. The indices indicate characteristics of the job that require physical or mental effort, mental evaluation of the job, friendly and supportive environment and hazardous substances. For all the transformed employment characteristics positive coefficients were found but only the coefficient on the hazardous substances variable was significant indicating that dangerous substances result in wage increases. For the objective risk measures only the injury rate coefficient proved to be positive and significant implying that accidents that result in lost workdays have an upward impact on wages. The probability of having a fatal accident imposes an upward pressure on wages but we cannot draw strong conclusions since the coefficient, although positive, is insignificant. We constructed a severity-adjusted measure to test the effect on injury severity on wages. Workers receive wage premia for increases in the severity of an accident. Finally, using two sources of risk, occupational illness and occupational injuries, we investigated the hypothesis that the estimated risk coefficients are sensitive to the source of risk. We concluded that workers are compensated for the risk of experiencing a nonfatal accident that results in lost workdays from an occupational illness or from an occupational injury.

APPENDIX

In the 1977 QES the workers were asked to report the presence and intensity of employment characteristics. In some questions the respondent had to choose from five possible answers i.e. My job requires that I keep learning new things. There are five possible answers: 1. strongly disagree,

2. disagree, 3. agree, 4. strongly agree, 5. no answer. Other questions allowed the individual to respond choosing either 1 or 5 i.e. Were you laid off from your present job at any time in the last year? 1 would mean that he was and 5 that he was not.

For the variables, LEARN, FAST, SKILL, HARD, CREATE, DIFF, SAY, SKILLS, BREAKS, PROCED, KNOW, NOSATIS, SPEED, KNOWEXP, REPET, HARDQT, NOTIME, AFTQT, HISTQS, IMPACT, MONEY, MEANING, ENERGY, DESERVE, RULES (see Tables 3-6 for variable definition) the possible answers were: 1. strongly disagree, 2. disagree, 3. agree, 4. strongly agree, 5. no answer.

For all the other explanatory variables the possible answers were 1. not at all true, 2. a little true, 3. somewhat true, 4. very true.

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COMPENSAZIONE DELLE DIFFERENZE SALARIALI E RISCHI DI LAVORO

In questo articolo si verifica l'ipotesi che il rischio di infortuni e morte produce delle differenze salariali compensative per gli infortuni sul lavoro. Vengono esaminati i guadagni salariali da rischio combinando misure di rischi soggettivi e oggettivi per gli Stati Uniti. Applicando una tecnica di indicizzazione vengono costruiti quattro indici che indicano le caratteristiche dei lavori che richiedono sforzo fisico o mentale, la valutazione mentale del lavoro, la piacevolezza dell'ambiente e le sostanze nocive. Le misure di rischio oggettivo comprendono le fatalità, la perdita di giorni di lavoro conseguente a malattie e infortuni professionali e una variabile aggiustata secondo la gravità dell'infortunio. L'analisi econometrica dimostra l'evidenza di premi salariali dovuti a malattie e incidenti professionali non mortali. Al contrario non si è trovata nessuna evidenza empirica di premi salariali per incidenti e malattie mortali.

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A TEST OF REGULATORY BEHAVIOR: THE CASE OF THE SECURITIES AND EXCHANGE COMMISSION

by
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The Securities Exchange Act of 1934 formally created the Securities and Exchange Commission (SEC) on June 1, 1934. While legal professionals and scholars are continually involved with the interpretation of the language of the regulations, they have not produced much research dealing with the empirical tests of the actual utility of the laws.

> Serious scientific research, as it is understood in other disciplines, is not a common pursuit of the legal profession. Lawyers, law professors, and judges are trained to engage in language analysis and precedent gathering and thus have a natural reluctance to undertake systematic research (Wolfson, 1976, 288).

Legal researchers have not engaged in examination and verification of issues that are of concern to those affected by the structure and power of the SEC as a semi-judiciary, semi-legislative, and semi-administrative body.

The Commission is composed of five Commissioners who are appointed by the President, with the advice and consent of the Senate for five-year terms. The Chairman is generally of the same political party as the president, but only three of the five commissioners may belong to the same political party. Based on this limitation, the agency advertises itself as independent of the executive. [1] If true, changes in political philosophy in the chief executive office should have no effect on the SEC's *enforcement* activity.

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[1] See *The Work of the SEC*, U.S. Securities and Exchange Commission, October 1986, p. 23.

Peltzman (1976) contends that enforcement activity and intensity by regulatory agencies varies with economic conditions, e.g., the regulators' view is more pro-business during a contractionary period and pro-consumer during an expansionary period. Freeman (1976) indicated concern with the significant control of the SEC over the economic life of American industry, and stated such power is still growing without examination by the judiciary. "We hope to utilize the services of outstanding economists who have devoloped a facility for dealing with large aggregates of data ..." (Cohen, 1968, p. 309).

The effect of cyclical economic conditions and the philosophical posture of the executive branch on the SEC's enforcement behavior and the intensity of its enforcement actions is examined in this research.

The Enforcement Process [2]

SEC investigations of possible violations of securities laws and the enforcement proceedings against potential violators are conducted through the Division of Enforcement. The Division is concerned with insider trading based on non-public information, market manipulation, sale of unregistered securities, adherence to the disclosure requirements by public companies, and fraudulent reporting by such companies. Lynch et al (1988) outlined the various aspects of the enforcement process and recent commission actions against violators. The Enforcement Division administers securities regulations through its office within SEC headquarters and the nine regional offices located throughout the United States.

Potential violations may come to the attention of the enforcement staff through various sources such as its own inquiries, other SEC decisions or other governmental agencies' referrals, tips from investors and others, news media data, consumers' complaints, market surveillance, and inspection of books and records of brokers/dealers. The staff initially evaluates information that has come to its attention. If the staff decides to pursue a case on the basis of their initial analysis of the evidence, two avenues of action are available:

(1) investigation, or
(2) matter under inquiry (MUI).

The first alternative is chosen if the staff feels information sufficient to

[2] See *Statistics on SEC's Enforcement Program*, a report by United States General Accounting Office, March 1985.

establish that the merit of the case has been acquired. Opening an MUI allows the staff up to 80 more working hours to research the matter. After this additional research is conducted, either the matter is closed or an investigation is opened.

An investigation may be conducted formally or informally. If the parties or witnesses involved are willing to cooperate and voluntarily provide information, an informal investigation is likely and the staff need not obtain the Commission's formal approval. When the staff needs to have subpoena power for calling witnesses and requisitioning of records, however, the Commission's formal approval must be obtained. There is no public disclosure about an investigation, whether formal or informal, at this point.

An investigation may involve an individual (individuals), and/or an entity (entities). Information about an investigation and/or findings cannot become available to the public if no enforcement action is taken. [3] Conversely, if an investigation results in an enforcement action or series of separate actions, against any number of individuals and/or entities involved, the matter is made public by publication in the SEC's Dockets. If the matter is not closed upon conclusion of an investigation, the Commission has two alternatives available for enforcement.

The first alternative is filing a civil injunctive action in a United States District Court against the defendants. Civil injunctions are court orders prohibiting existing or imminent violations of securities laws, or other equitable relief such as a freeze on funds to protect investors. The second alternative is an administrative proceeding before an administrative law judge. Under administrative proceedings the remedies against the respondent may include barring, suspending, or limiting activities in the securities industry. The enforcement staff, in any case, must obtain the Commission's specific approval for each enforcement action before an official complaint is filed. In lieu of these more costly legal proceedings, a consent agreement may be negotiated between the Commission and the proposed defendant in which the defendant accepts the sanctions and remedies without admitting or denying the charges.

Regulations and Economic Cycles

Economic conditions may suggest competing effects on SEC enforce-

[3] During the examination period (1977-1984), over forty percent of all cases investigated were closed without any enforcement action.

ment activity. Ostrovityanov and Reinhold (1963) stated, "safeguarding monopoly profit in period of crisis is the number one task of state-monopoly regulation". Accordingly, dividing the general population broadly into consumers and producers, I assume that producers suffer more severely, in relative financial terms, during a period of economic contraction. This implies that the level of risk assumed by each interest group is different in changing economic conditions and government interventions during such contractionary periods are more pro-business. Using a parallel argument, Peltzman (1976) contends that consumers should benefit from government intervention during an expansionary period. Governments, ideally, reduce uncertainty in economic exchanges. These assertions appear consistent with the public interest theories of regulatory behavior.

According to the argument that regulatory behavior is affected by economic conditions, and given the role of the SEC as the securities market regulator, the SEC's enforcement activities would have to be reduced during a contractionary period. On the other hand, relaxed SEC enforcement activity combined with reduced profit margins might provide incentives for businesses to violate regulatory prescriptions during contractionary periods. One former director of the SEC's enforcement division has been quoted, "Anytime you have a recession, you have people who cook the books to give an appearance of contrived profitability" (Kallen, 1984).

Therefore, one may logically expect to see an increase in the number of actions taken by the Commission.

Political Process and Influences

Macroeconomic research has produced evidence supportive of "Political Business Cycle" theory that assumes parties are only concerned about re-election, voters have short memories, and the economy is an exploitable Phillips curve. Advocates of this theory state that behavior of the two parties is identical and their desire is to stimulate the economy close to election time (Nordhaus, 1975; and MacRae, 1977; Tufte, 1978).

Another macroeconomic theory, the "Partisan View", rejects the hypothesis of identical outcome under two types of policies. The "partisan view" studies indicate that differences in policies produce different economic outcomes (Havrilesky et al., 1975; Hibbs, 1977; Beck, 1982, 1984; Havrilesky, 1987; Alesina and Sachs, 1988).

Whether the activities of the SEC's Division of Enforcement are subject to the "political influence" from the executive branch deserves considera-

tion. If the Commission's claim of political independence is valid, any change in political affiliation of the executive branch, e.g., Democratic or Republican, should have no effect on the workload of the division of enforcement, especially since the relative size of human and financial resources of the division remained unchanged over the period of 1977-1984.

Methodological Issues

The eight-year period from January 1, 1977 through December 31, 1984 is used in this research. This period covered the terms of two different Presidents from the two dominant political parties in the United States. Also, the world in general, and the United States in particular, experienced significant changes in the economic conditions during this time period. During the first four-years, three of five commissioners were Democrat, including the Chairman, and during the second four-years, three of the commissioners were Republican, including the Chairman.

The enforcement division received about one third of the total resources of the SEC's funding annually. The number of direct enforcement staff, during this period, did not change significantly. During the period of this study, the average age of pending enforcement cases was approximately 800 days and, on average, to initiate civil injunctions and administrative proceedings took 350 and 550 days, respectively. The number of shares traded on various exchanges, the number of first time registrants, the number of broker-dealer registrations, and the number of investment company registrations, however, grew significantly during this period. No sample selection is necessary since all of the litigated cases during the examination period are included, for the purposes of the tests of this study.

Research Hypotheses

Two sets of procedures, non-parametric and regression-based, will be used to examine the following economic cycle and political influence hypotheses:

H_{o1}: *Ceteris paribus*, the number of cases filed by the SEC during periods of economic expansion is significantly smaller than that during the contractionary periods.

H_{o2}: *Ceteris paribus*, the same number of cases is filed by the SEC

against entities during a Republican administration and a Democratic administration.

These procedures will be based on the number of cases filed over different sub-periods. These tests will be conducted by dichotomizing the examination period into two sub-periods of economic expansion/contraction and Democratic/Republican political parties.

To test the "Economic Cycle" and "Political Influence" hypotheses, the Ordinary Least Square (OLS) regression approach will be used. To test H_{o1} the monthly number of litigations filed will be regressed on a composite index, published by the U.S. Department of Commerce. The three-month and twelve-month lags are included to capture the effect of economic conditions at the time the case was *initiated*. This, in substance is a covariance test as follows:

$$C_t = \beta_0 + \beta_1 \text{Index}_t + \beta_2 \text{Index}_{t-3} + \beta_3 \text{Index}_{t-12}$$

where C_t is the number of litigations filed during month t, and Index_{t-i} is the index for month $t-i$ ($i = 0$, 3, or 12).

The hypothesis is tested by examining the significance of β_1, β_2, and β_3. According to the theory presented earlier, the expected value of β_j is larger than zero. Therefore, the null hypothesis will be, $H_{o1} : \beta_j = 0$, this implies a one-tailed test. If the null hypothesis is correct, then β_j has an expected value not significantly different from zero. If alternative hypothesis is correct, then $E(\beta_j)$ is significantly larger or smaller than zero.

To test the significance of political influence, H_{o2}, the above regression analysis will be broken into two sub-periods of Democratic and Republican presidencies, and the effect of such partitioning on the coefficients will be examined.

The non-parametric tests involve the relative frequency of cases filed by the SEC. For the purposes of these tests the number of filings during each month will be counted. Then, each month is ranked based on the number of litigations during that month. The Mann-Whitney test will be performed based on the above-explained rankings to examine the two hypotheses, H_{o1} and H_{o2}.

The test statistic T will be computed as follows:

$$S = \sum_{i=1}^{n} R(X_i)$$

$$T = S - \frac{n(n+1)}{2}$$

where S is the sum of the ranks assigned to each month from the period,
X is one of the two types sub-periods, and
n is the number of months in sub-period X.

The limitation of this analysis is that each effect is tested assuming independence.

Research Design

Several time intervals have to be identified. The partitioning of the time and period identifications is essential to operationalize the methods explained above. These time intervals include, first, periods with different economic conditions (expansion or contraction), second, identification of the intervals associated with specific political parties.

It is necessary to determine the periods of economic contraction and expansion during the years 1977-1984 for the purposes of testing the "Economic Cycle" hypothesis. To determine changes in economic conditions, generally some surrogate(s) or index of economic activities is used. Sources of such an index must be evaluated on the basis of economic significance, statistical adequacy, timing, conformity, smoothness, and currency (U.S. Department of Commerce, 1977). For the purposes of this research, the "four roughly coincident indicators", one of the composite indexes published by the U.S. Department of Commerce, is used. This composite index tends to be more reliable as cyclical indicator than any of its components. Changes in the index were used to identify expansionary (positive) or contractionary (negative) periods.

The "Political Influence" hypothesis will be tested to assess the effect of the political environment on the SEC's enforcement activities. Such an examination is possible since the test period covers terms of two presidents from different political parties, Presidents Carter (Democrat) and Reagan (Republican).

Regression Tests

In this part of the analysis, 72 monthly observations of the number of cases filed by the SEC over a six-year period, 1978-1980 and 1982-1984, were used to determine the relative importance of economic conditions on the number of cases filed during each month. The first year of each adminis-

TABLE 1

REGRESSION ANALYSIS OF ECONOMIC CYCLE HYPOTHESIS
The Effect of Economic Conditions on the Number of Cases Filed

Period	Estimated Coefficients (t-statistic)				Adjusted R^2	Durbin-Watson
	Constant β_0	Index β_1	Index_{t-3} β_2	Index_{t-12} β_3		
Six Year	74.71 (3.23)	−0.097 (0.25)	0.043 (0.11)	−0.462* (−3.42)	0.17	1.63
Democratic	120.32 (3.47)	−0.259 (−0.67)	0.077 (0.20)	−0.456* (−2.82)	0.26	2.04
Republican	31.19 (0.59)	0.295 (0.42)	−0.038 (0.05)	−0.266 (−0.66)	0.10	1.50

* Significant at 0.05 level.

tration was excluded in order to allow for the lag between initiation and public announcement of the enforcement.

The results of the regression over six-year and three-year periods are presented in Table 1. At the significance level of $\alpha = 0.05$, the tabulated values of t-statistics with 68 and 32 degrees of freedom are approximately 1.6676 and 1.6939, respecively. β_3 appears to be significantly smaller than zero at the 0.05 level for the first two regressions. However, following the same analysis, β_1 and β_2 do not appear to be significantly different from zero.

The results indicate that the twelve-month lagged index has negative correlation influence with the number of cases. The negative sign of the coefficient leads us to believe that the enforcement activities increase with economic downturns. Furthermore, contemporaneous values of the index have no significant relationship with the number of enforcement actions taken in a given month.

The Durbin-Watson statistics for three explanatory variables with 68 degrees of freedom indicate that the lower and upper bounds of the test are approximately 1.40 and 1.66 with 2.5 percent significance. Therefore, the residual auto-correlation test based on the calculated Durbin-Watson is not conclusive for the six-year period regression. The lower and upper limit of the Durbin-Watson Statistics, for analysis of four-year periods, are 1.05 and 1.63, with 2.5 percent significance, respectively. This indicates that during

the first sub-period the regression parameters are stable. However, the auto-correlation test for the second sub-period is indecisive.

To find out whether the regressions for the two sub-periods differ, the Chow test was constructed as follows. Let Rss_1, Rss_2, and Rss_3 be the residual sum of squares of the six-year period, Democratic period, and Republican period, respectively:

$$\text{Define } Rss_4 = Rss_2 + Rss_3$$
$$\text{and } Rss_5 = Rss_1 - Rss_4$$

Then, the following F-statistic is computed:

$$F = \frac{Rss_5/K}{Rss_4/(N_1 + N_2 - 2K)}$$

where N_1 = number of months during 1978-1980 period (36),
N_2 = number of months during 1982-1984 period (36), and
K = number of parameters estimated (4).

If the computed F is larger than the critical F value from the tables, the hypothesis that the two sub-period regression results are the same will be rejected.

The computed F value is 1.05, and the F-value from the tables with 4 and 64 degrees of freedom at the 0.05 level is 2.53. No significant change has occurred between the two sub-periods; i.e., the SEC activities, with respect to the economic conditions.

Non-parametric Tests

"Economic Cycle" and "Political Influence" hypotheses were tested using the one-tailed and the two-tailed Mann-Whitney test, respectively. The Null hypotheses tested were:

$$H_{o1}: E\left(\begin{array}{c}\text{Number of cases filed}\\ \text{in an Expansion}\\ \text{period}\end{array}\right) < E\left(\begin{array}{c}\text{Number of cases filed}\\ \text{in a Contraction}\\ \text{period}\end{array}\right)$$

$$H_{o2}: E\left(\begin{array}{c}\text{Number of cases filed}\\ \text{during a Democratic}\\ \text{administration}\end{array}\right) = E\left(\begin{array}{c}\text{Number of cases filed}\\ \text{during a Republican}\\ \text{administration}\end{array}\right)$$

Two T-values, as formulated earlier, were computed and tested for their significance. For the two-tailed test the large sample approximation of the critical region was computed (Conover, 1971). For the one-tailed test W_α applies

$$W_{1-\alpha/2} = \frac{nm}{2} + X_{1-\alpha/2}\sqrt{nm\,(n+m+1)/12}$$

$$W_{\alpha/2} = \frac{nm}{2} - X_{\alpha}/2\sqrt{nm\,(n+m+1)/12}$$

where α is the significance level,
n is the number of Democratic/Republican months,
m is the number of Republican/Democratic months, and
X is the $1-\alpha/2$ quantile of a standard normal random variable.

To examine the effect of economic conditions on the enforcement activities of the SEC, as indicated by the number of filings, 72 months during the periods of 1978-1980 and 1982-1984 were ranked. Each month was classified as either expansionary or contractionary, each month was based on the index of twelve months ago. The reason for this lagged indexing is the approximate one-year time period between initiation and disclosure of an enforcement action.

The results shown in Table 2 indicate that the null hypothesis, H_{01} *cannot* be rejected, since the T-Values are smaller than the critical value of

TABLE 2
MANN-WHITNEY RANK TEST OF ECONOMIC CYCLE HYPOTHESIS
The Effect of Economic Conditions on the Enforcement Actions Based on Number of Filings

	Combined	Democrat	Republican
Expansionary:			
Number of Months	48	31	17
Number of Cases Filed	1442	911	531
Contractionary:			
Number of Months	24	5	19
Number of Cases Filed	692	119	573
T-Value	621.5	118.5	179.5
$W_{0.95}$	740	120.3	223.4
Null Hypothesis	not rejected	not rejected	not rejected

W_α at α equal to the 0.05 significance level, for the six-year period and the two sub-periods. This conclusion is consistent with that stated earlier based on regression analysis, i.e. the number of enforcement actions is smaller during an expansionary period compared to that during a contractionary period. These results, however, do not confirm the theory of pro-business behavior of regulators, conditioned on economic contractions.

To test the "Political Influence" hypothesis, the number of cases were ranked by matching the years two, three, and four of the two administrations. It is possible that investigations initiated during the third and fourth year of one administration are carried over and litigated during the first and second years of another administration. Therefore, a two-year test for the third and fourth years combined was performed. These results are presented in Table 3. The *T*-Values in all cases are outside of the critical region as

TABLE 3

MANN-WHITNEY RANK TEST OF POLITICAL INFLUENCE HYPOTHESIS
The Association between Administration and
Enforcement Ranked Based on Number of Litigations

Period	1978 vs 1982	1979 vs 1983	1980 vs 1984	1979-80 vs 1983-84
Democratic:				
Number of Months	12	12	12	24
Number of Cases filed	395	334	301	635
Republican:				
Number of Months	12	12	12	24
Number of Cases filed	314	393	397	790
T-value	110	32	30	122
$W_{0.975}$	106	106	106	383
$W_{0.025}$	38	38	38	193
Null Hypothesis	rejected	rejected	rejected	rejected

determined by the $W_{1\alpha/2}$ and $W_{\alpha/2}$. H_{o2} is rejected for all single-year tests and the two-year test at the 0.05 level. The evidence presented for single-year and two-year periods is consistent with the "Political Influence" hypothesis, that is, SEC enforcement intensity varies with changes in the executive office.

Discussion

This research examined the effect of economic and political factors on the SEC enforcement process. Further research similar to the study by Nourayi (1990) and Kunitake (1987), in this area of accounting regulation is necessary to evaluate the effect of the enforcement process on financial reporting and securities markets.

The results of economic cycle hypothesis tests indicated that the level of enforcement activity is not reduced during periods of economic downturns. This appears consistent with the expectations of increased violations during contraction periods and contradicts the theory of pro-business regulatory behavior.

The rejection of the pro-business regulatory behavior seems reasonable since SEC does not regulate any specific industry and its activities affect all business segments. Significantly, the level of enforcement activity varied with the political party of the president. The results of testing the political influence hypothesis indicated that the enforcement process is affected by the political environment. These results support the "partisan view" theory and are consistent with the evidence provided by macroeconomic researchers indicating differences in policies of the two political parties.

While the statistical procedures used to test the hypotheses of this research may be improved or enhanced, the results provide us with a better understanding of the SEC's enforcement function in the securities market. For example, advances in theories of economic cycles may provide a better economic index, and additional information about the dates of initiation and litigation of each case may refine the partitioning, etc.

In testing the political influence, changes in the business cycle are not clearly accounted for. To some extent the discrimination of different economic conditions may be necessary when breaking the time period for the purpose of analysis.

The analysis of the political influence on the SEC activities would be, in part, based on the temporal analysis of cases of fraud and the efficiency of the enforcement staff in discovering and taking enforcement action during the tenure of two different administrations affiliated with two different political parties. One problem is that some cases do take longer than others to process. However, if it can be assumed that fraudulent activities are independent of the political parties and President affiliation, occurrence of such cases is random with respect to the two sub-periods of this study.

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UN TEST DI COMPORTAMENTO REGOLATORIO: IL CASO DELLA SEC

Questo studio analizza le imposizioni della SEC in relazione ai mutamenti delle condizioni economiche e politiche. Il test di comportamento regolatorio ha rivelato che le imposizioni sono più intense durante i periodi di congiuntura economica sfavorevole indipendentemente dall'affiliazione politica dell'organo esecutivo. La teoria di una comportamento dei regolatori favorevole agli affari nei periodi di contrazione economica non è confermato. I risultati dimostrano che l'affiliazione politica dell'organo esecutivo influisce sul numero dei casi trattati dalla Commissione. Questi risultati indicano differenze fra le amministrazioni e sono conformi alla teoria della « visione partigiana » introdotta nella letteratura macroeconomica.

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REAL INTEREST RATES IN EIGHT OECD COUNTRIES

by
ANTHONIE KNOESTER * and WIM MAK **

1. *Introduction*

For almost two decades badly synchronized international interest rate movements are responsible for big shocks in international capital flows and exchange rates. Not only the variability of interest rate movements but also the level of interest rates are a matter of permanent concern to policy makers. In the 1970s, nominal interest rates lagged behind the increased inflation rate – resulting in relatively low or even negative real interest rates – with as a consequence that it became attractive to incur debt. In the early 1980s the decrease in nominal interest rates lagged behind actual decreased inflation rates, resulting in relatively high real interest rates. These developments led, amongst other things, to the smouldering debt crisis in Latin America and Africa. However, not only the Third World but also areas who did not suffer from the debt crisis – such as the OECD area – had their problems with high real interest rates. In particular, high real interest rates will act as a drag on more investments, which in most OECD countries is urgently needed to stimulate economic growth and to create more employment. In economics most analyses on interest rates concentrate on the explanation of nominal interest rates instead of real interest rates. In addition, they concentrate on the explanation of interest rates from a national

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angle without any comparison whatsoever with what is happening with foreign interest rates. In this paper we try to diminish this lack of information by concentrating on the analyses of *real* interest rates in an *international* setting. The real interest rates considered here are analysed using the current inflation rate instead of the expected one; which means that the current rate is used as a proxy of the expected one. The plan of the paper is as follows. In Section 2 we will discuss past actual developments of real interest rates in eight OECD countries. Section 3 deals with a classification of the main determinants of real interest rates. Section 4 provides an empirical elaboration for eight OECD countries of the foreign determinants of real interest rates while Section 5 concentrates on the empirical elaboration of the domestic determinants. We will end with the main conclusions in Section 6.

2. *Actual Development in Real Interest Rates in Eight OECD Countries*

Post-war development in real interest rates in OECD countries becomes much clearer when it is compared with real interest rate development over a more extended period. Figure 1 shows the development of real interest rates since the last century for the Netherlands, the United Kingdom and the United States [1]. It appears from this that current real interest rates are relatively high. At the same time it can be concluded that such levels are not an exceptional phenomenon. In the second half of the nineteenth century too such real interest rate levels were apparent. In addition, exceptionally high levels of real interest rates were apparent in the 1920s and 1930s, which was mainly caused by deflation at that time. Figure 1 further suggests that the dynamics of national real interest rates have an important international dimension. The sub-periods which can be distinguished by respectively high, low and even negative real interest rates generally correspond to the three countries specified. Finally, it can be concluded that substantial fluctuations in real interest rates have occurred. And what is more, relatively high real interest rate levels are not so much an exception but rather the heralding of negative interest rates. Negative real interest rates appeared four times in the period after 1870, namely around the change of the century, at the end and right after the first world war, in the years of the second world war and finally in the 1970s.

[1] Other countries are not included in this long-term survey because of the lack of adequate data. The data used for the Netherlands, the United States and the United Kingdom are from HOMER (1977). The real interest rate is defined as the nominal long-term interest rate minus the percentage change in the consumer price level.

FIGURE 1. Real Interest Rates in the Netherlands, the United States and the United Kingdom (1870-1990).

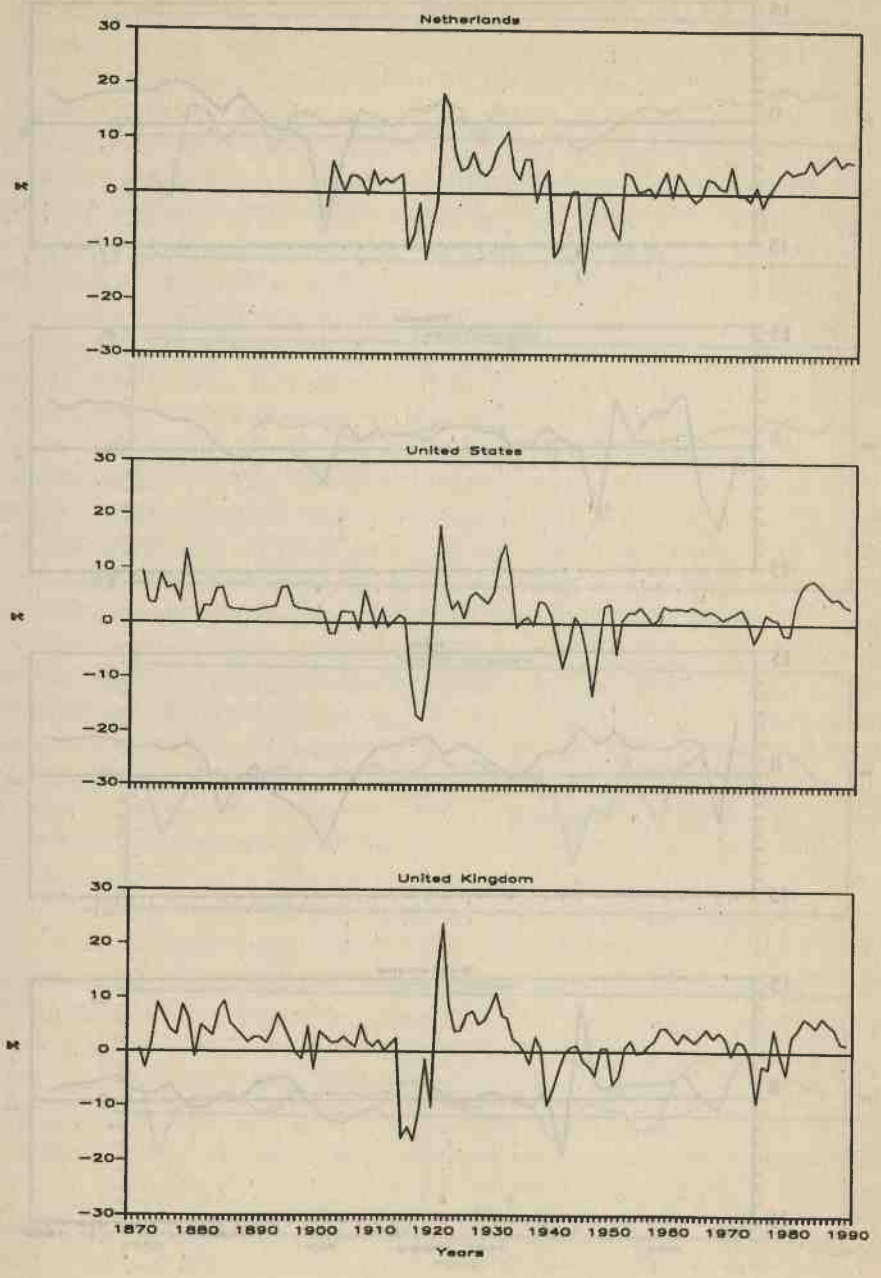

FIGURE 2. Real Interest Rates in Eight OECD Countries in the Post-war Period (1950-1990).

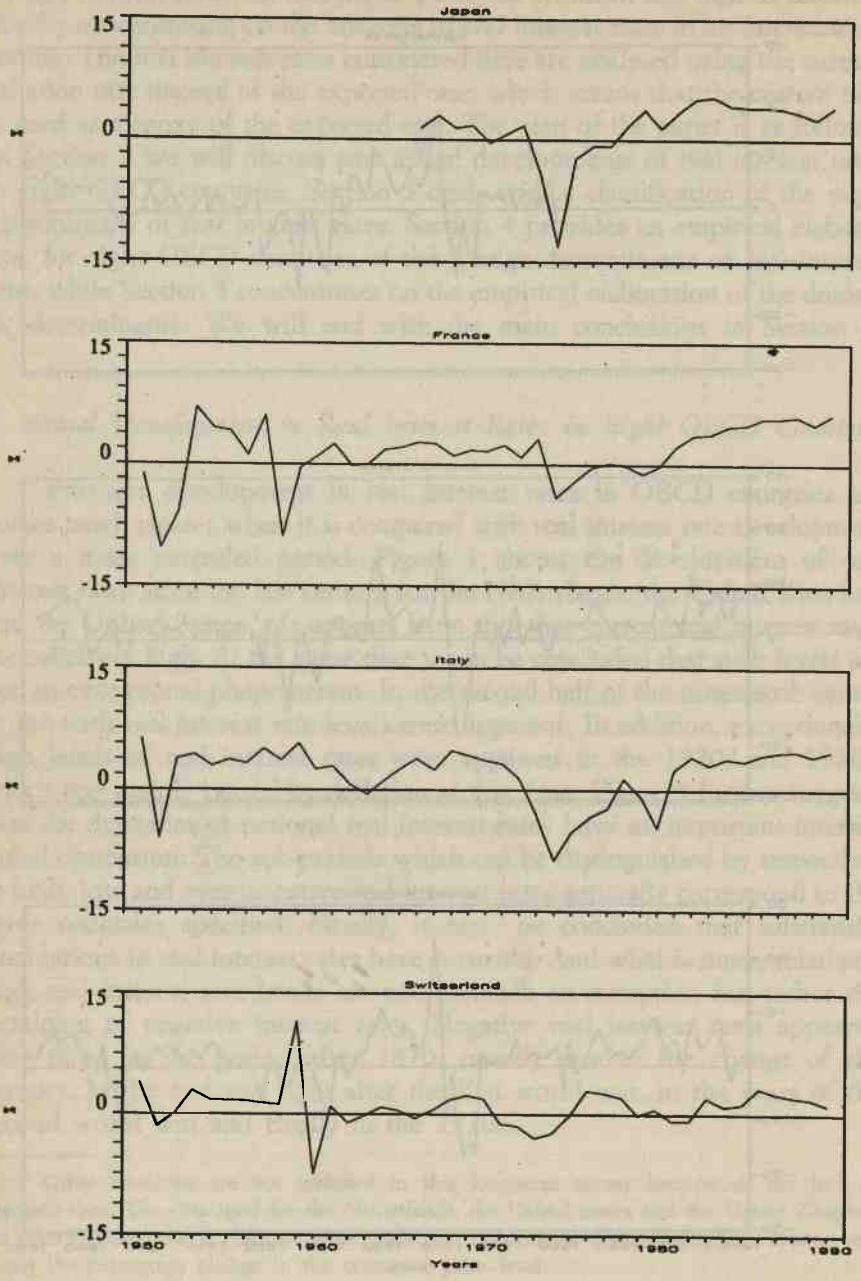

FIGURE 2. (*continued*)

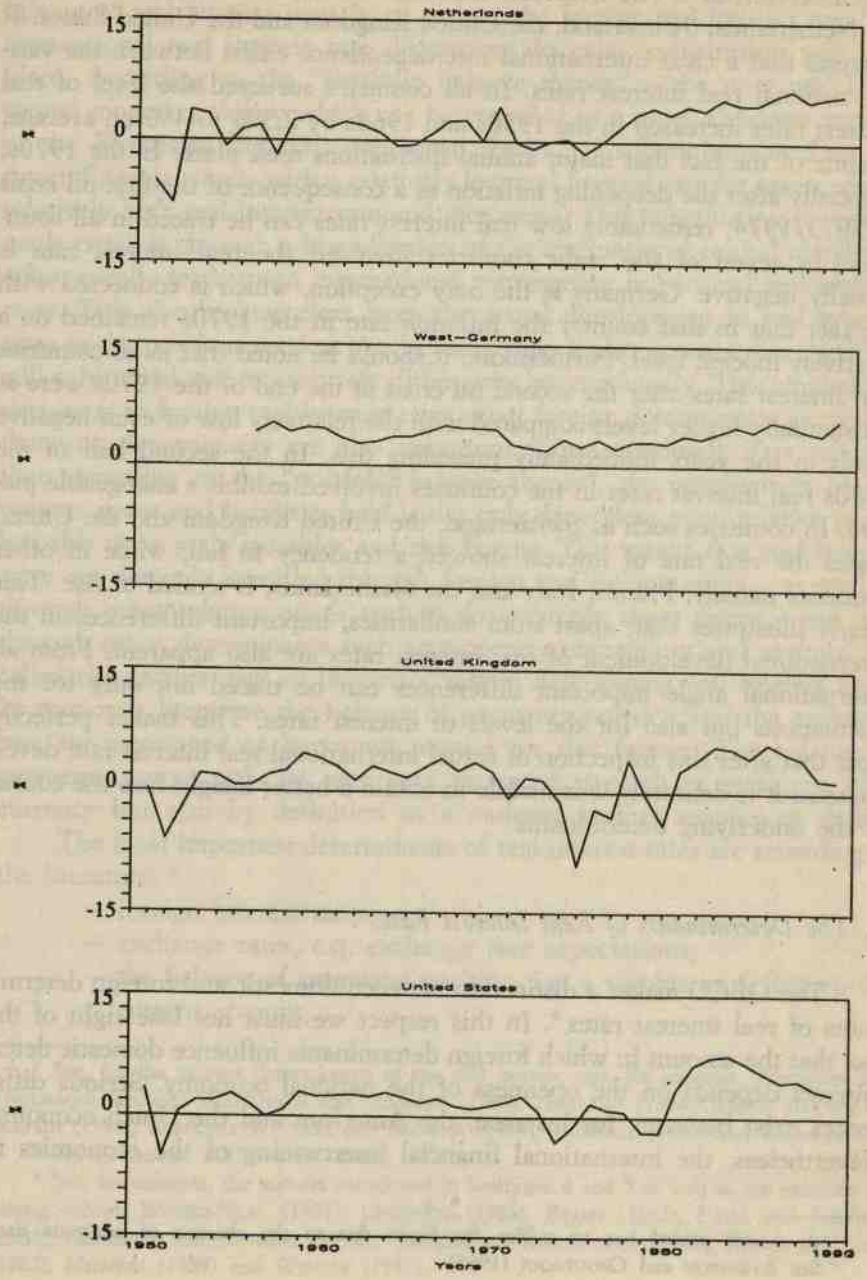

Figure 2 shows real interest rate development since 1950 in eight OECD countries [2]. The overview includes France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States. It suggests that a clear international interdependence exists between the various national real interest rates. In all countries surveyed the level of real interest rates increased in the 1950s and 1960s by 2.5% to 4% on average, in spite of the fact that major annual fluctuations took place. In the 1970s, especially after the deepening inflation as a consequence of the first oil crisis in 1973/1974, remarkably low real interest rates can be traced in all countries. In seven of the eight countries involved the real interest rate is actually negative. Germany is the only exception, which is connected with the fact that in that country the inflation rate in the 1970s remained on a relatively modest level. Furthermore, it should be noted that in all countries real interest rates after the second oil crisis at the end of the 1970s were at substantially higher levels compared with the relatively low or even negative levels in the years immediately preceding this. In the second half of the 1980s real interest rates in the countries involved exhibit a changeable picture. In countries such as Switzerland, the United Kingdom and the United States the real rate of interest showed a tendency to fall, while in other countries namely, France, Italy and the Netherlands, it tended to rise. This clearly illustrates that, apart from similarities, important differences in the international development of real interest rates are also apparent. From an international angle important differences can be traced not only for the fluctuations but also for the levels of interest rates. This makes perfectly clear that after this inspection of actual international real interest rate developments it is definitely worthwhile to obtain a better insight into the course of the underlying determinants.

3. *The Determinants of Real Interest Rates*

The OECD makes a distinction between domestic and foreign determinants of real interest rates [3]. In this respect we must not lose sight of the fact that the amount in which foreign determinants influence domestic determinants depends on the openness of the national economy. Serious differences exist between, for instance, the American and the Dutch economy. Nevertheless, the international financial intertwining of the economies in

[2] A shorter period has to suffice for Japan due to the absence of adequate data.
[3] See ATKINSON and CHOURAQUI (1985).

the OECD area have so strongly increased that even for the American real interest rate foreign influences can be substantial. An obvious foreign determinant of real interest rates is, of course, the foreign real interest rate [4]. If international real interest rate differences do exist, substitution will take place. According to the "portfolio balance theory" – the now widely-accepted monetary theory which can be regarded as a more elaborate version of the Keynesian liquidity preference theory [5] – substitution evolves between financial assets with a relatively low real interest rate for assets with a relatively high real interest rate and vice versa. This substitution process, made possible through a liberalisation of the international capital markets, automatically leads to an international convergence in national real interest rates. This also became clear from the actual development in real interest rates in the previous section. At the same time it also appears that there are still substantial real interest rate differences internationally. This emphasises that, next to foreign real interest rates other foreign determinants as well as domestic determinants are also important. Correspondingly it is relevant that, according to the "portfolio balance theory", the composition of the various assets and liabilities held is not only dependent upon relative prices but also upon scale variables and risk factors. This means that real interest rates are not only specified through foreign real interest rates – as well as through other relative prices such as for example share prices – but also through other determinants such as monetary uncertainty and savings. So-called risk factors play an important role in determining real interest rates. In economic literature the balance of payments position and the exchange rate are mentioned as important proxies for risk factors. The balance of payments cannot only be seen as a proxy of strength or weakness of a currency but also by definition as a national savings surplus or deficit.

The most important determinants of real interest rates are according to the literature: [6]

- foreign interest rates;
- exchange rates, c.q. exchange rate expectations;
- the balance of payments position, i.e. a surplus or deficit on the current account;

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[4] See, for the various determinants of the real interest rate, for example, ATKINSON and CHOURAQUI, op. cit., BLANCHARD and SUMMERS (1984), HOLLAND (1984), BARRO and SALA-I-MARTIN (1990), BLUNDELL-WIGNALL and BROWNE (1991), MUNDELL (1963) and TOBIN (1965).

[5] See KNOESTER (1979, 1984, 1988).

[6] See, for example, the authors mentioned in footnotes 4 and 5 as well as the opinions of, among others, BONSER-NEAL (1991), CECCHETI (1986), EVANS (1985), FAMA and GIBBONS (1982), FELDSTEIN and SUMMERS (1978), FRANKEL and MACARTHUR (1988), HAFER and HEIN (1982), MISHKIN (1989) and WILCOX (1983).

- savings;
- the profit ratio, i.e. the level of investment of industry;
- the liquidity ratio;
- the government budget deficit;
- monetary or exchange rate uncertainty;
- the fiscal climate;
- the macroeconomic climate, c.q. the business cycle;
- the share index.

Although this list is not exhaustive, it can certainly be seen as representative for the determinants of the real rate of interest. Each determinant can be placed in economic, c.q. monetary theory. Thus, for example, savings can be traced back to the so-called "loanable fund theory", the liquidity ratio to the "Keynesian liquidity preference theory" and monetary and exchange rate uncertainties to the risk factors of the "portfolio balance theory".

Table 1 shows the development in a number of sub-periods of a large number of determinants. First, it should be noted that at first glance no direct link can be traced between the real interest rate and these determinants. In the Netherlands, for example, the average real interest rate increased between 1981 and 1985 while the exchange rate of the guilder in the same years depreciated against the dollar. In Japan, however, the real rate of interest increased in the same period with an appreciation of the yen against the dollar. According to economic theory one would expect an increasing real interest rate in combination with a depreciating currency, following the contention that a depreciation risk – through a higher risk premium – should be compensated by a higher real interest rate. A similar conclusion can be drawn with respect to the link between the current account of the balance of payments and the real interest rate. Countries with a weak balance of payments position, such as evolved in the United Kingdom and the United States, showed, on the basis of an expected larger exchange rate risk, no evident higher real interest rates. From this initial inspection of the available data it should, however, not be concluded that the relation between the various determinants and the real interest rate as suggested by the theory does not exist at all. Regression analysis may offer more clearness on this point and is therefore the main theme of the remainder of this paper.

4. *Foreign Determinants of the Real Interest Rate*

For most OECD countries the foreign real interest rate seems to be by

TABLE 1

ACTUAL DEVELOPMENT IN REAL INTEREST RATE DETERMINANTS

Netherlands	1962-1972	1973-1980	1981-1985	1986-1989
real interest rate	1.05	1.53	5.00	6.26
savings ratio[1]	26.92	23.21	22.02	22.90
profit ratio[1]	-	38.44	46.16	45.75
current account[1]	0.11	1.05	3.16	2.50
government budget deficit[1]	1.46	2.59	6.90	3.47
real share price[2]	124.08	67.44	67.35	131.93
liquidity ratio (M1)[1)]	24.39	20.19	20.14	24.23
liquidity ratio (M2)[1)]	34.39	33.20	34.64	43.05
national product %	5.11	2.70	1.02	2.38
exchange rate against the dollar	3.56	2.41	2.91	2.14
Germany	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	3.96	2.71	4.49	5.20
savings ratio[1]	27.02	22.91	21.06	24.60
profit ratio[1]	-	31.71	31.40	-
current account[1]	0.59	0.74	1.06	4.38
government budget deficit[1]	0.16	1.71	1.84	0.95
real share price[2]	104.74	73.30	71.46	122.48
liquidity ratio (M1)[1)]	16.02	16.20	16.37	18.49
liquidity ratio (M2)[1)]	-	-	-	-
national product %	4.35	2.51	1.16	2.80
exchange rate against the dollar	3.80	2.28	2.61	1.90
United Kingdom	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	2.47	- 1.88	4.96	4.87
savings ratio[1]	19.05	17.18	17.02	15.88
profit ratio[1]	-	29.76	39.04	-
current account[1]	0.15	0.71	1.38	- 2.05
government budget deficit[1]	0.78	4.93	3.69	0.25
real share price[2]	110.45	64.95	76.66	136.91
liquidity ratio (M1)[1)]	20.51	15.83	14.59	
liquidity ratio (M2)[1)]	-	-	-	
national product %	2.96	1.80	1.94	3.63
exchange rate against the dollar	0.39	0.48	0.65	0.62
United States	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	2.20	- 0.53	6.70	4.75
savings ratio[1]	19.36	19.62	16.88	14.98
profit ratio[1]	-	32.37	34.26	-
current account[1]	0.33	0.06	- 1.36	- 2.93
government budget deficit[1]	0.98	2.32	4.50	3.56
real share price[2]	141.23	97.31	87.58	140.86
liquidity ratio (M1)[1)]	23.56	17.62	15.46	16.79
liquidity ratio (M2)[1)]	-	-	-	-
national product %	3.84	2.58	2.64	3.26
exchange rate against the dollar	1.00	1.00	1.00	1.00

TABLE 1 (*continued*)

Japan	1962-1972	1973-1980	1981-1985	1986-1989
real interest rate	1.49	- 1.87	4.67	3.70
savings ratio[1]	35.37	33.43	30.86	32.75
profit ratio[1]	-	41.26	40.10	-
current account[1]	0.78	0.13	1.84	3.15
government budget deficit[1]	1.09	4.34	6.54	-
real share price[2]	42.30	55.94	74.05	196.67
liquidity ratio (M1)[1)]	30.72	33.04	29.12	29.80
liquidity ratio (M2)[1)]	-	-	-	-
national product %	9.88	4.10	3.82	4.45
exchange rate against the dollar	353.4	260.14	236.68	144.83
France	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	1.57	- 0.64	4.10	5.96
savings ratio[1]	25.28	25.01	19.58	20.53
profit ratio[1]	-	32.44	31.48	-
current account[1]	0.14	0.08	- 0.84	- 0.33
government budget deficit[1]	0.62	0.85	2.92	2.16
real share price[2]	158.86	91.43	77.70	168.72
liquidity ratio (M1)[1)]	33.60	28.70	27.83	27.36
liquidity ratio (M2)[1)]	-	54.95	53.09	49.75
national product %	5.27	2.98	1.52	3.23
exchange rate against the dollar	5.10	4.53	7.47	6.32
Italy	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	2.69	- 3.51	3.68	4.79
savings ratio[1]	23.60	25.54	22.24	20.78
profit ratio[1]	-	34.50	38.44	48.78
current account[1]	1.81	- 0.61	0.92	- 0.40
government budget deficit[1]	3.96	9.91	13.55	11.83
real share price[2]	383.15	121.21	74.99	188.56
liquidity ratio (M1)[1)]	36.21	46.97	38.85	36.75
liquidity ratio (M2)[1)]	-	-	-	-
national product %	4.71	4.21	1.60	3.15
exchange rate against the dollar	619.44	766.88	1535.00	1365.50
Switzerland	**1962-1972**	**1973-1980**	**1981-1985**	**1986-1989**
real interest rate	0.33	0.35	0.59	2.64
savings ratio[1]	30.85	27.15	27.16	30.85
profit ratio[1]	-	-	-	-
current account[1]	0.02	3.08	4.28	4.65
government budget deficit[1]	0.11	0.77	0.32	- 0.34
real share price[2]	148.34	80.65	74.10	123.48
liquidity ratio (M1)[1)]	-	-	54.29	30.24
liquidity ratio (M2)[1)]	-	-	-	-
national product %	4.24	0.84	1.40	2.83
exchange rate against the dollar	3.76	2.35	2.18	1.60

Source: OECD, various statistics. [1)] = as a percentage of GDP; [2)] = the nominal share index deflated with the consumer price index, % = percentage change. The figures refer to averages for the various data in the sub-periods mentioned.

far the most important foreign determinant of the real interest rate. In this section we will concentrate on quantifying this relationship with the help of the usual one stage least squares (OLS) regressions. As a point of departure we have chosen the so-called partial adjustment hypothesis [7]. According to this hypothesis the actual real interest rate will continually tend towards a "desired" level of real interest rates. The desired level of real interest rates is in turn a function of domestic and foreign determinants. The adjustment of the actual real interest rate to the desired real interest rate does not necessarily have to happen within one period which is in our analysis one year. The speed of adjustment can affect several periods depending upon the so-called "adjustment coefficient", i.e. of the proportion in which per period only a partial adjustment of the actual real interest level to the desired real interest level will take place. The aforementioned train of thought can be symbolised as follows:

$$(rl-pc)_t = (rl-pc)_{t-1} + \alpha\,[(rl-pc)_t^* - (rl-pc)_{t-1}] \qquad (1)$$

where:

$(rl-pc)_t$ = real interest rate in period t
$(rl-pc)_{t-1}$ = real interest rate in period $t-1$
$(rl-pc)_t^*$ = desired real interest rate in period t
α = adjustment coefficient.

Equation (1) shows that the actual real interest rate in period t is equal to the actual real interest rate in the previous period $(t-1)$ and the proportion in which the difference between the desired real interest rate and the actual real interest rate in the previous period is erased. The speed with which this discrepancy is erased depends upon the estimated adjustment coefficient α. If this adjustment coefficient equals 1.0, for example, then the adjustment of the actual real interest rate to the desired real interest rate is complete in the same period. An adjustment coefficient of less than 1.0 indicates a partial adjustment which takes longer than one period.

Equation (1) can be rewritten as follows:

$$(rl-pc)_t = (1-\alpha)\,(rl-pc)_{t-1} + \alpha\,(rl-pc)_t^* \qquad (2)$$

In addition it is assumed:

$$(rl-pc)_t^* = f\,[(rl-pc)_p^f,\ o_p,\ b_p,\ x_t] \qquad (3)$$

[7] See e.g. HENDERSHOTT and DE LEEUW (1970), KNOESTER (1979) and GOODHART (1989).

in which $(rl-pc)^f_t$ = foreign real interest rate in period t, o_t = the government budget deficit in period t, b_t = balance of payments in period t, x_t = other determinants of the desired real interest rate. In other words, the desired real interest rate depends upon domestic and foreign determinants of the real interest rate as discussed earlier. Substitution of equation (2) by equation (3) leads to the following basic specification which has been estimated:

$$(rl-pc)_t = (1-\alpha)(rl-pc)_{t-1} + \alpha\beta_1 (rl-pc)^f_t + \\ + \alpha\beta_2 o_t + \alpha\beta_3 b_t + \alpha\beta_4 x_t \qquad (4)$$

in which $(1-\alpha)$ represents the estimated coefficient for the one period delayed real interest rate and $\alpha\beta_1$, $\alpha\beta_2$, etc., the to be estimated coefficients for the domestic and foreign determinants of the real interest rate. The adjustment coefficient α can, of course, be calculated from the estimated equation. If, for example, the estimated coefficient for the one period lagged real interest rate is 0.5, then α equals 0.5 too. According to the given derivation then the speed of adjustment of the actual real interest rate to the desired rate takes 2 periods.

Table 2 contains the regression results for the cases in which we suppose the desired real interest rate is completely dependent upon the foreign real interest rate. The foreign real interest rate is put together on the basis of a basket of a number of foreign real interest rates regarded as relevant for each country. Thus the development of the real interest rate in Germany is of major significance for the Dutch real interest rate, while for a country such as the United States the situation is different. Four relevant baskets are tested for each country in the regression analysis. Table 3 contains the weights of the baskets whereby the best results have been reached. It is remarkable that for the Netherlands and Switzerland the exclusive link with the German real interest rate gives better results than baskets of foreign real interest rates in which, for example, the American, British and the Japanese interest rates play a role. The American real interest rate has the most significant influence on countries such as Japan and the United Kingdom, followed at some distance by France and Italy. It should, however, be emphasised that the approach followed here in the composition of foreign real interest rates is a tentative one. Various refinements are possible such as baskets with annual changing weights based on the composition of international capital flows. Finally, it should be noted that, except for the foreign real interest rate, other foreign determinants of the real interest rate are also possible, such as the exchange rate c.q. ex-

TABLE 2

REGRESSION RESULTS FOR THE LINK BETWEEN REAL INTEREST RATES AND FOREIGN REAL INTEREST RATES

	one year lagged real interest rate	foreign real interest rate	constant	R^2	DW	F-statistic
Netherlands	0.63 (4.52)	0.79 (2.34)	-2.07 (-1.66)	0.66	2.04	23.73
Germany	0.38 (2.94)	0.28 (4.37)	1.99 (4.30)	0.73	1.53	31.80
United Kingdom	0.18 (1.36)	1.41 (5.07)	-2.98 (-3.23)	0.66	1.99	22.99
United States	0.40 (2.72)	0.77 (4.32)	-0.22 (-0.55)	0.79	0.86	44.96
Japan	0.28 (1.36)	1.07 (2.48)	-2.51 (-1.77)	0.51	1.66	10.49
France	0.40 (3.57)	0.59 (5.63)	0.17 0.53	0.80	2.49	48.57
Italy	0.34 (3.01)	1.09 (5.85)	-1.80 (-3.43)	0.81	1.38	52.04
Switzerland	0.47 (3.06)	0.62 (2.37)	-1.99 (-1.92)	0.50	1.55	11.97

NOTE: Annual averages have been used for the 1963-1989 period. A shorter estimation period of 1967-1989 is maintained for Japan due to the lack of available data. The real interest rate is defined as the difference between the level of the long term interest rate and the percentage change in the consumer price index. The foreign real interest rate is composed according to the weights of Table 3. Figures without parentheses represent the estimated regression coefficients. Figures in parentheses represent the respective T values. R^2 = squared correlation coefficient; DW = Durbin-Watson statistic.

change rate expectations and the balance of payments position. The balance of payments position will be examined in the next section. Experiments in which the effective exchange rate was added to the estimated equations in Table 2 led in only three of the surveyed countries, namely Italy, the Netherlands and the United States, to a significant improvement in the results [8]. It can be concluded that the regression results as reflected in Table

[8] The estimated relationships for these countries are:

TABLE 3

BASKETS OF THE FOREIGN REAL INTEREST RATES AS USED IN THE REGRESSION ANALYSIS

	Nether-lands	Germany	United Kingdom	United States	Japan	France	Italy	Switzer-land
Netherlands		1.0						
Germany	0.33		0.33					0.33
United Kingdom		0.5		0.5				
United States		0.25	0.25		0.25	0.25		
Japan		0.5		0.5				
France			0.33	0.33	0.33			
Italy		0.25	0.25	0.25	0.25			
Switzerland		1.0						

NOTE: This matrix contains the weights that have been used in the composition of the foreign real interest rates for the respective countries. The weights reflected in this matrix gave the best estimation results compared with other weights.

2 confirm our first impression in Section 2, namely that there is a clear international link between the various national real interest rates. At the same time it must be emphasised that this international link does not completely explain the development of the real interest rates. Obviously, domestic determinants also play a significant role.

Italy:
$$rl-pc = \underset{(0.85)}{0.11\,(rl-pc)_{t-1}} + \underset{(6.27)}{1.46\,(rl-pc)^f} + \underset{(2.23)}{0.04\,wk^e} \underset{(-3.28)}{-5.26}$$
$$R^2 = 0.88 \quad DW = 1.34 \quad F = 42.09$$

the Netherlands:
$$rl-pc = \underset{(0.74)}{0.14\,(rl-pc)_{t-1}} + \underset{(2.19)}{0.78\,(rl-pc)^f} + \underset{(3.13)}{0.09\,wk^e} \underset{(-3.61)}{-11.28}$$
$$R^2 = 0.78 \quad DW = 1.86 \quad F = 20.60$$

the United States:
$$rl-pc = \underset{(1.51)}{0.24\,(rl-pc)_{t-1}} + \underset{(3.88)}{0.74\,(rl-pc)^f} + \underset{(2.13)}{0.08\,wk^e} \underset{(-2.08)}{-6.71}$$
$$R^2 = 0.83 \quad DW = 0.86 \quad F = 28.26$$

In which wk^e represents the effective exchange rate. The positive link found between real interest rates and effective exchange rates indicates that an appreciation of the exchange rate will lead to an increase in the real interest rate. This reveals an important causality problem, since on the other hand a higher real interest rate will lead to an appreciation of the exchange rate. This is why in the next section we have decided against an addition of the effective exchange rates in the estimated equations.

5. *Domestic Determinants of Real Interest Rates*

First, it should be emphasised that in a world economy with goods, services and financial flows intertwined with each other there is in practice naturally no question of strictly domestic determinants. Even so-called domestic determinants of real interest rates, such as savings, are the result of domestic and foreign determinants. As a consequence of this simultaneity one should be careful in interpreting possible links between real interest rates and domestic and foreign determinants respectively. Having this in mind the regression equations of Table 2 serve as a point of departure for our analysis of the domestic determinants of real interest rates. The following determinants per country were added to these equations: [9]

- the liquidity ratio defined as *M*1 or *M*2 as a percentage of GDP
- the government budget deficit as a percentage of GDP
- the balance of payments (i.e., the surplus or deficit on the current account) as a percentage of GDP
- the savings ratio, i.e. savings as a percentage of GDP
- a business cycle indicator presented through the growth in the production volume of industry
- the real share price, i.e. the share price index divided by the consumer price index
- the profit ratio, i.e. gross profits as a percentage of GDP
- the investment ratio, i.e. gross investment as a percentage of GDP.

It leads to poor overall results if all these determinants are added simultaneously per country to the equations of Table 2. Only a limited number of determinants – differing per country – appeared then to be significant. A better result was obtained through experimenting per country with the addition of a limited and varying set of determinants. Table 4 contains the results of this. It appears from this in the first place that in all countries the fit increases as a consequence of the addition of a set domestic determinants. At the same time it appears from this that domestic determinants – and therefore also national monetary and other economic policies – are definitely of importance in explaining national real interest rates and that as a logical consequence of this they are a *debet* to the occurrence of international real interest rate differences.

If we look at the results in more detail we notice the following find-

[9] We are concerned here, however, with a selection of the determinants mentioned in Section 3, made on the basis of the availability of consistent data.

ings. First, it is remarkable that the savings ratio – in economic literature regarded as an important determinant of the real interest rate – contributes significantly to the explanation of real interest rates in four of the eight OECD countries specified. This implies that a policy directed towards an increase in the savings ratio can contribute towards a decrease in the high real interest rates. For example, in the United States, an increase in the savings ratio by 1 percentage point of GDP leads in the longer term to a decrease in the real interest rate of 2.0% which is certainly not negligible [10]. It is further remarkable that in only two of the eight OECD countries the government budget deficit makes a significant contribution to the explanation of real interest rates. This does not mean that the size of the government budget deficit is insignificant for real interest rate developments but that there are obviously more important determinants of the real interest rates [11]. Furthermore, for France, Germany and the United States a negative link can be traced between the real interest rate and the liquidity ratio, which indicates a certain relevance for the Keynesian liquidity preference theory. In this respect a tight monetary policy can lead to an increase in the real interest rate while, on the other hand, a policy of monetary ease can make the real interest rate to drop.

It also appears that the business cycle i.e., the growth rate in the volume of production, makes a contribution to the explanation of the real interest rate level in only two countries viz. the United Kingdom and the United States. As a consequence, from an international angle a policy aiming at a slowing down of demand seems certainly not the proper means of lowering high real interest rates. Finally, a remarkable finding is that for three countries, namely, Germany, Italy and the United States, a significant, positive link is found between the balance of payments and the real interest rate. On the basis of the theory one should, however, rather expect a negative link as a result of the contention that a deficit on the current account will lead to a higher real interest rate, because in this way a surplus on the capital account of the balance of payments can compensate the deficits on the current account. The positive link found between the current account and the real interest rate points entirely in another direction. Possi-

[10] The adjustment coefficient of 0.51 found for the United States has been taken into account here. For the European Countries an increase in the savings ratio with 1 percentage point of GDP leads in the long run to a decrease in real interest rates of about 0.5% (viz. 0.64% for the Netherlands, 0.60% for Italy and 0.43% for Switzerland).

[11] A large government deficit can also exercise an influence upon the real interest rate in an indirect way via the fact that a large government deficit usually leads to a reduction in savings and thereby to a lower savings ratio.

TABLE 4

REGRESSION RESULTS FOR THE LINK BETWEEN REAL INTEREST RATES, FOREIGN REAL INTEREST RATES AND OTHER DETERMINANTS

	one year lagged real interest rates	foreign real interest rate	liquidity ratio	govern-ment budget deficit	balance of payments (current account)	savings ratio	volume of production	constant	R^2	DW	F-statistic
Netherlands	0.33 (2.37)	1.11 (3.91)				- 0.43 (- 3.76)		7.94 (2.79)	0.79	2.31	29.20
Germany	0.46 (3.63)	0.31 (5.01)	- 0.45 (- 2.71)	0.18 (1.93)	0.18 (2.04)			8.60 (3.76)	0.81	1.66	18.03
United Kingdom	0.14 (1.05)	1.30 (4.82)					0.43 (1.95)	- 3.61 (- 3.88)	0.71	2.19	18.37
United States	0.49 (3.36)	0.60 (4.34)	- 0.24 (- 2.71)		1.80 (4.32)	- 1.02 (- 4.46)	0.35 (2.66)	23.17 (4.92)	0.90	1.66	29.18
Japan	0.30 (1.63)	1.17 (3.02)		0.64 (2.48)				- 3.85 (- 2.80)	0.63	1.84	10.85
France	0.33 (2.74)	0.56 (5.15)	- 0.08 (- 1.07)					2.86 (1.21)	0.80	2.46	30.69
Italy	0.12 (1.26)	0.86 (5.40)			0.70 (5.00)	- 0.52 (- 2.59)		11.43 (2.25)	0.91	1.75	55.97
Switzerland	0.49 (3.12)	0.86 (5.39)				- 0.22 (- 2.13)		3.79 (1.31)	0.58	1.70	10.66

NOTE: Annual averages have been used for the 1963-1989 period. A shorter estimation period of 1967-1989 is maintained for Japan due to the lack of available data. The real interest rate is defined as the difference between the level of the long term interest rate and the percentage change in the consumer price index. The foreign real interest rate is comprised according to the weights of Table 3. The liquidity ratio (for the narrow definition of the money supply, *M*1), the government budget deficit, the savings ratio and the balance of payments (current account) are expressed as a percentage of national income. The volume of production is in percentage changes. Figures without parentheses represent the estimated regression coefficients via the one stage least squares (OLS) method. Figures in parentheses represent the respective T-values. R^2 = squared correlation coefficient; DW = Durbin-Watson statistic.

bly this positive link should be interpreted in terms of the impact of monetary policy on the real interest rate. In the case of a surplus on the current account the monetary authorities may, as happened in the past years in Germany, decide on the implementation of a tight monetary policy, for fear of inflation, in order to try through this to absorb the flood of foreign liquidity through a cut down of the creation of domestic liquidity.

6. *Conclusions*

From this analysis follows in any case that the phenomenon of current high real interest rates can only be usefully explained through recognising the importance of the influence of foreign determinants. In all eight OECD countries examined it appeared that foreign real interest rates makes a significant and important contribution to the explanation of the national real interest rates. At the same time it can be concluded that this explanation is still incomplete. This indicates that domestic determinants play a considerable role in explaining real interest rates and that, in other words, national monetary and other economic policies can definitely influence the level of real interest rates [12]. From our regression analysis it appeared that in addition to the foreign real interest rate, the savings ratio, the government budget deficit and the liquidity ratio contribute to the explanation of real interest rates. This implies that policies directed at an increase in the savings ratio, a limitation in the government budget deficit and a policy of monetary ease, can contribute to a lowering of current high levels of real interest rates.

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[12] This is in line with earlier empirical evidence provided, for example, by MISHKIN (1984). According to him empirical evidence strongly rejects the hypothesis of real rate equality across countries.

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SAGGI REALI D'INTERESSE IN OTTO PAESI DELL'OCSE

L'articolo inizia con una discussione sullo sviluppo dei saggi reali d'interesse nel passato e delle loro determinanti per la Francia, Germania, Italia, Giappone, Olanda, Svizzera, Regno Unito e Stati Uniti. In seguito viene sviluppato un modello di aggiustamento parziale che serve da punto di partenza per una analisi empirica di questi sviluppi nel periodo 1963-1989. Si trova che le determinanti esterne come i saggi reali d'interesse esteri contribuiscono in modo significativo e importante alla spiegazione dei saggi reali d'interesse nazionali. Inoltre, le determinanti nazionali, come il saggio di risparmio, il disavanzo pubblico e il tasso di liquidità hanno pure un ruolo considerevole. Questi risultati indicano che le politiche nazionali monetarie e fiscali possono influenzare considerevolmente gli sviluppi del tasso reale d'interesse.

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ADVERTISING UNDER UNCERTAINTY

by
SATYAJIT GHOSH *

I. *Introduction*

A wide variety of analytical models have been formulated to examine the optimal advertising decision of a firm under uncertainty. In his pioneering paper Horowitz (1970) has considered two types of firm – a quantity setting price taker and a price setting quantity taker. He shows that a risk averse firm advertises less than a risk neutral firm for a given output level or a given price level. In their static model, similar to Horowitz's, Dehez and Jacquemin (1975) have shown that a risk averse firm will charge lower price than the risk neutral firm or the firm that operates under certainty. They also conclude that the impact of uncertainty on advertising decision is somewhat ambiguous. It depends on the price-advertising interaction effects. Both Horowitz and Dehez-Jacquemin have incorporated uncertainty in their models in a very special way. They have assumed that the random demand function is additive in the stochastic disturbance term. Using the CAPM framework to analyze the joint price (quantity) advertising decision for the monopolist under uncertainty, Brick and Jagpal (1981) provide an interesting departure from the usual expected utility maximizing framework (used by Horowitz as well as Dehez and Jacquemin). They have also introduced uncertainty in the random demand function in a very flexible form which includes additive and multiplicative uncertainty as special cases. After generalizing the Dorfman-Steiner (1954) result they examine interesting comparative static results (which are not attempted by either Horowitz or

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Dehez and Jacquemin) of exogenous shifts in demand and changes in risk. In particular they examine the impact of risk on the advertising and pricing decisions. The precise effects are shown to depend on the covariance between the random disturbance term and the random rate of return of the market portfolio as well as on the risk adjusted price elasticity of demand. They emphasize how, depending on these two factors, it is possible to confirm or refute the earlier results obtained by Horowitz and Dehez and Jacquemin.

In this paper we examine the optimal advertising behavior of a monopolistic firm under uncertainty in a framework that is different from the earlier models of Horowitz, Dehez and Jacquemin and Brick and Jagpal. Here we assume that while advertising favorably affects the level of demand, its precise quantitative impact on the level of demand is uncertain and consequently unknown to the firm at the time the firm makes the advertising and production decisions. Specifically, the random variable that captures the uncertain impact of advertising enters the demand function nonlinearly. In an expected utility maximizing framework we analyze and compare the optimal advertising and output decisions for the risk averse firm, the risk neutral firm and the firm that faces no uncertainty. It is important to note that unlike the findings of Dehez and Jacquemin (or that of the traditional theory of firm under uncertainty) here we find a significant difference between the behavior of the risk neutral firm and the firm that operates under conditions of certainty. We also derive several comparative static results including the effects of changes in the inherent uncertainty associated with the impact of advertisement.

The structure of the paper is as follows. The model is presented in Section II. In Section III, we examine the optimal advertising and output decisions for the risk averse firm, the risk neutral firm and the firm under certainty. It is shown that, given few general conditions imposed on the demand function, the optimal levels of advertisement and output can be ranked for the above three types of firms. Comparative static results are derived in Section IV. We examine the effects of a change in the cost of advertising and changes in the inherent uncertainty associated with the impact of advertisement, in the sense of a mean preserving spread and a first degree stochastic dominance, on the levels of optimal advertisement and output. Concluding remarks are made in Section V.

II. *Assumptions and Specifications of the Model*

Consider an imperfectly competitive firm with the inverse demand

function $h(x, z)$ with $h_1 < 0$, $h_2 > 0$, $h_{22} < 0$ (the subscripts denote the variables with respect to which the partial derivative is calculated) where x is the level of output and z measures the impact of advertisement. This specification of the demand function is similar to Hadar (1969) who discusses non-stochastic models of monopolistic competition [1]. For simplicity we assume that $h_{12} = 0$. We may note that Dehez and Jacquemin address to similar cross effects to analyze the impact of uncertainty on the firm's advertising level. However here the assumption of $h_{12} = 0$ adds to great computational simplicity. As we will see later on it will allow us to analyze optimal advertising and output decisions separately. Furthermore this assumption will directly have a bearing on the optimal output decision of the firm but in contrast with the model of Dehez and Jacquemin it will play no role in determining the optimal advertising decision.

While advertising is known to increase the demand for the product, its precise quantitative impact is however uncertain. Letting y denote the aggregate physical level of advertising, z may be defined as

$$z = \alpha y$$

where α is a positive random variable with a smooth continuous density function $g(\alpha)$ and a distribution function $G(\alpha)$. Without any loss of generality, we may assume that, $E(\alpha) = 1$, where E denotes the expected value.

The profit of the firm is given by

$$\pi = xh(x, \alpha y) - c(x) - qy - f \tag{1}$$

where $c(x)$ denotes the cost of production (with $c'' \geqq 0$), f the fixed cost and q the per unit cost of advertising. As regards the cost of advertising it is assumed that either the firm uses only one advertising medium with a specific price for advertisement or that in the case of multiple advertising media the prices charged by the different media always change in the same proportion. The firm's utility function $u(\cdot)$ is a von Neumann-Morgenstern utility function with $u'' \leqq 0$ depending on whether the firm is risk-averse or risk-neutral, where the strict inequality holds for the risk averse firm

[1] This specification of the demand function is particularly useful in emphasizing the interrelationship between pricing and non pricing decisions. For example, consider a non-stochastic environment where z is the actual level of advertising. Let $p_1 = h(x_1, z_1)$ and $p_0 = h(x_1, 0)$ i.e., with the level of advertisement at z_1 the firm can sell x_1 amount of the output and can charge a price p_1, but if the firm decides to eliminate advertisement altogether it has to lower the price to p_0 offering a price discount of $(p_1 - p_0)$ in order to be able to sustain the sale at x_1. See HADAR (1969) for an interesting discussion of such price discount.

and the equality holds for the risk neutral firm. The firm's objective is to maximize the expected utility from profit,

$$\phi = Eu(\pi) = Eu(xh(x, \alpha y) - c(x) - qy - f) \tag{2}$$

with the appropriate choices of the output level, x, and the advertising level, y. It is evident that the advertising decision is taken by the firm prior to the realization of the random variable, α. We also assume that production is not instantaneous. Hence the firm must also decide upon a production plan prior to the realization of demand in the market. Thus, following Leland (1972), both x and y are ex-ante choices. It is also assumed that all the output that is produced must be sold in the same time period and cannot be stored for future sale because either the cost of storage is prohibitively high or the product is highly perishable.

The first order conditions for the above maximization problem are given by

$$\phi_x = Eu' \cdot [h(x, \alpha y) + xh_1(x, \alpha y) - c'] = 0 \tag{3}$$

$$\phi_y = Eu' \cdot [xh_2(x, \alpha y)\alpha - q] = 0 \tag{4}$$

While equation (3) shows the equality between the expected value of marginal utility of marginal revenue and that of the marginal cost of production, equation (4) shows the equality between the expected value of marginal utility of marginal revenue from advertising and that of the marginal cost of advertising.

The appropriate second order conditions are assumed to be satisfied [2].

As a point of future reference, note that if the firm faces no uncertainty as to the impact of advertising, the firm's profit is given by,

$$\bar{\pi} = xh(x, y) - c(x) - qy - f \tag{5}$$

The corresponding first order conditions are [3]

$$\bar{\pi}_x = h(x, y) + xh_1(x, y) - c' = 0 \tag{6}$$

$$\bar{\pi}_y = xh_2(x, y) - q = 0. \tag{7}$$

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[2] See appendix for the Second Order Conditions.

[3] See appendix for the Second Order Conditions.

III. *Optimal Advertising and Output Decisions*

To help analize the optimal advertising decision of the firm, we define μ as the elasticity of the marginal effect of advertising,

$$\mu = h_{22}z/h_2$$

We first compare the advertising levels chosen by the risk averse firm and the risk neutral firm. Letting $[xh_2\alpha - q]$ be denoted by Θ_1, rewrite (4) as,

$$Eu'\,\Theta_1 = 0 \tag{4'}$$

Note that $\partial u'/\partial\alpha = u''xh_2y \leqq 0$. The strict inequality (equality) holds for the risk averse (risk neutral) firm. Also, note that, $\partial\Theta_1/\partial\alpha = xh_2(1+\mu)$. Thus for the risk averse firm, if $(1+\mu) > 0$, $\partial\Theta_1/\partial\alpha > 0$ and consequently, COV $(u', \Theta_1) < 0$, where COV denotes covariance [4]. Hence, utilizing (4') we get,

$$Eu'\,E[xh_2\alpha - q] > Eu' \cdot [xh_2\alpha - q] = 0$$

and thus, since $Eu' > 0$

$$E(xh_2\alpha) - q > 0. \tag{8}$$

Now, for the risk neutral firm, the optimal condition (4) is reduced to,

$$E(xh_2\alpha) - q = 0. \tag{9}$$

Since $xh_2\alpha$ is a decreasing function of y, we can easily conclude from (8) and (9) that the risk averse firm advertises less than the risk neutral firm.

Similarly, if $(1+\mu) < 0$, the risk averse firm advertises more than the risk neutral firm.

The above discussion is summarized in the following proposition.

Proposition 1. If $(1+\mu) > 0$, the risk averse firm advertises less than the risk neutral firm, while if $(1+\mu) < 0$, the risk averse firm advertises more than the risk neutral firm.

We now turn to the comparison between the risk neutral firm and the firm that faces no uncertainty. In the traditional firm theory there is usually

[4] Suppose $V(\Theta)$ and $W(\Theta)$ are differentiable functions of the random variable, Θ. Then if $dV/d\Theta$ and $dW/d\Theta$ are of the same (opposite) signs, COV $(V, W) > (<) 0$.

no difference between the behavior of the risk neutral firm and the firm facing no uncertainty. But as we will demonstrate here the advertising levels (and the output levels) are different for the risk neutral firm and the firm that faces no uncertainty. The reason for this difference with the traditional firm theory lies in our specification of demand uncertainty. Usually, in the standard firm theory (see for example, Sandmo, 1971; Batra and Ullah, 1974) as well as in Dehez and Jacquemin profit is a linear function of the random variable, but in our model profit is a concave function of α [5].

As for the risk neutral firm, first note that the optimal condition (9) can be rewritten as,

$$E(\alpha h_2) = q/x \tag{10}$$

Now (αh_2) can be shown to be concave in α, provided $(1 + \mu) > 0$ and $\partial\mu/\partial z \leqq 0$. (The proof is given in the appendix). Using Jensen's inequality we get [6]

$$h_2(x, y) > E(\alpha h_2)$$

Consequently, from (10),

$$xh_2(x, y) > q \tag{11}$$

Comparing (11) with (7), and noting that $h_{22} < 0$, we can easily conclude that the risk neutral firm advertises less than the firm facing no uncertainty [7]. Hence we have the following proposition.

Proposition 2. If $(1 + \mu) > 0$, and $\partial\mu/\partial z \leqq 0$, the risk neutral firm advertises less than the firm under certainty.

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[5] GHOSH (1991) developes a location choice model in presence of technological uncertainty where profit turns out to be a concave function in the random variable.

[6] If Θ is a random variable such that $E(\Theta) = \bar{\Theta}$ and the distribution of Θ is non-degenerate at $\bar{\Theta}$, Jensen's inequality states that if $F(\Theta)$ is a concave function, $E[F(\Theta)] < F(E(\Theta))$ and if $F(\Theta)$ is a convex function then, $E[F(\Theta)] > F(E(\Theta))$.

[7] The sufficient conditions $(1 + \mu) > 0$ and $\frac{\partial \mu}{\partial z} \leq 0$ are satisfied by a wide variety of demand functions, for example, $h(x, z) = mx^{-a} + nz^b$, $m > 0$, $n > 0$, $a > 0$, $0 < b < 1$. It should also be noted that the demand functions that satisfy these restrictions are not limited to the class of separable demand functions with $h_{12} = 0$. Consider, for example, $h(x, z) = 1 + tx^{-a} z^b$, $t > 0$, $a > 0$, $0 < b < 1$. Note that for both these demand functions, $1 + \mu = b > 0$ and $\frac{\partial \mu}{\partial z} = 0$.

We now can rank the optimal advertising levels for the three types of firms discussed above. Let y_n^*, y_a^* and y_c^* denote the respective optimal advertising levels for the risk neutral firm, the risk averse firm and the firm that faces no uncertainty. The following proposition is then immediate.

Proposition 3. If $(1 + \mu) > 0$ and $\partial\mu/\partial z \leqq 0$, then $y_c^* > y_n^* > y_a^*$.

Turning to the comparative analysis of the output decisions of the three types of firms, we first compare the optimal output levels of the risk averse firm with that of the risk neutral firm. Letting $[h + xh_1 - c']$ be denoted by Θ_2, rewrite (3) as,

$$Eu' \Theta_2 = 0 \tag{3'}$$

Note that since $h_{12} = 0$, $\partial\Theta_2/\partial\alpha = yh_2$. Thus for a risk averse firm $\partial u'/\partial\alpha$ and $\partial\Theta_2/\partial\alpha$ are of opposite signs. Hence COV $(u', \Theta_2) < 0$. Thus utilizing (3') we get

$$Eu' E[h + xh_1 - c'] > Eu' \cdot [h + xh_1 - c'] = 0$$

and, since, $Eu' > 0$,

$$E(h + xh_1) - c' > 0 \tag{12}$$

Now, for the risk neutral firm, the optimal condition (3) is reduced to,

$$E(h + xh_1) - c' = 0 \tag{13}$$

Noting that marginal revenue, $h + xh_1$, decreases with x and that marginal cost, c' is, by assumption, nondecreasing in x, we can conclude from (12) and (13) that, the risk averse firm's optimal output is less than that of the risk neutral firm. This result is summarized in the following proposition.

Proposition 4. The optimal output of the risk averse firm is less than that of the risk neutral firm.

To compare the optimal output levels for the risk neutral firm and the firm facing no uncertainty consider the optimality condition (13) for the risk neutral firm. It is clear that h is a concave function in α. Thus by applying Jensen's inequality to (13) and noting that $h_{12} = 0$, we get,

$$h(x, y) + xh_1(x, y) - c' > E(h(x, \alpha y) + xh_1(x, \alpha y)) - c' = 0 \tag{14}$$

In other words the optimal output decision for the risk neutral firm entails,

$$h(x, y) + xh_1(x, y) - c' > 0 \tag{14'}$$

Comparing (14') with the optimality condition (6) for the firm that faces no uncertainty we can easily conclude that the optimal output of the risk neutral firm is less than that of the firm facing no uncertainty. Hence we have the following proposition.

Proposition 5. The optimal output of the risk neutral firm falls short of the optimal output of the firm that faces no uncertainty.

Finally, letting x_n^*, x_a^* and x_c^* denote the optimal output levels for the risk neutral firm, the risk averse firm and the firm that faces no uncertainty, we can rank the output levels for all the three types of firms in the following proposition.

Proposition 6. $x_c^* > x_n^* > x_a^*$.

IV. *Comparative Static Results* [8]

We now analyze the effects of changes in the cost of advertising and the inherent uncertainty of advertisement as captured by the distribution of the random variable, α, on the optimal levels of advertising and output. For determinate results and computational simplicity we limit our analysis to the risk neutral firm with additively separable demand function. Given that the nature of demand uncertainty described here is inherently more complex than the usual price uncertainty model for a price taking firm where profit turns out to be a linear function in the random variable, it is not surprising that we need to invoke the assumption of risk neutrality to derive determinate results. The assumption of additively separable demand function (with $h_{12} = 0$) is used for computational ease.

IV.a. *Effects of changes in the advertising cost.* – First note that, $\phi_{xq} = 0$, $\phi_{yq} = -1$. Using (3) and (4) and the corresponding second order conditions for the risk neutral firm, we get,

$$y_q = \partial y/\partial q = \phi_{xx}/D \quad < 0 \tag{15}$$

[8] Calculations for the comparative static results are provided in the appendix.

$$x_q = \partial x/\partial q = -\phi_{xy}/D \quad < 0 \tag{16}$$

where $[D]$ is the Hessian associated with the second order conditions.

As it is expected, when q, the per unit cost of advertising, increases, the firm lowers the level of advertising. Consequently, an increase in q also adversely affects the level of output.

IV.b. *Effects of changes in uncertainty.* – We first consider the effects of a marginal increase in uncertainty in terms of a mean-preserving spread, i.e., the increase in uncertainty is captured by blowing up the distribution of the random variable, α, around the constant mean. In order to analyze such increase in uncertainty, define $\hat{\alpha}$ as

$$\hat{\alpha} = r\alpha + \eta \tag{17}$$

where r and η are shift parameters and initially $r = 1$, $\eta = 0$. An increase in r above its initial value of 1 leads to an increase in the variance as well as the expected value of $\hat{\alpha}$. Thus in order to restore the original mean, the increase in r must be accompanied by a decline in η by an amount such that,

$$\frac{d\eta}{dr} = \eta' = -E(\alpha) = -1 \tag{18}$$

Replacing α by $\hat{\alpha}$ in the optimal conditions (3) and (4) for the risk neutral firm, we now evaluate ϕ_{xr} and ϕ_{yr} at $r = 1$ and $\eta = 0$. Thus we have,

$$\phi_{xr} = yE[b_2(\alpha - 1)] < 0$$

$$\phi_{yr} = xE[b_2(\alpha - 1)(1 + \mu)] < 0$$

(The calculations for the determination of the above signs are provided in the appendix).

Consequently

$$y_r = (\phi_{xy}\phi_{xr} - \phi_{xx}\phi_{yr})/D < 0 \tag{19}$$

$$x_r = (\phi_{xy}\phi_{yr} - \phi_{yy}\phi_{xr})/D < 0 \tag{20}$$

With the increase in uncertainty, since profit is a concave function in α, the firm is worse off and hence it reduces the level of advertising. Consequently, the level of output also declines.

Finally, we investigate the effects of an increase in the expected impact of advertising on the level of demand. Let us define $\hat{\alpha}$ as

$$\hat{\alpha} = \alpha + k, \quad k > 0 \tag{21}$$

It is clear that the distribution function $H(\cdot)$ of $\hat{\alpha}$ differs from the distribution function $G(\cdot)$ of α by a horizontal displacement of length k. Hence H dominates G in the sense of First Degree Stochastic Dominance (see Hadar and Russell, 1978). To analyze such a change in uncertainty, we substitute α by $\hat{\alpha}$ in (3) and (4) and evaluate ϕ_{xk} and ϕ_{yk} at $k = 0$. Hence, we have,

$$\phi_{xk} = yE(h_2) > 0$$

$$\phi_{yk} = xEh_2(1 + \mu) > 0, \quad \text{given } (1 + \mu) > 0.$$

Thus, we can conclude,

$$y_k = (\phi_{xy}\phi_{xk} - \phi_{xx}\phi_{yk})/D \quad > 0 \tag{22}$$

$$x_k = (\phi_{xy}\phi_{yk} - \phi_{xk}\phi_{yy})/D \quad > 0 \tag{23}$$

As the expected impact of advertising becomes more favorable, the firm increases its level of advertising. Consequently, the level of output also increases.

V. *Conclusion*

We have analyzed the optimal advertisement and output decisions of an expected utility maximizing monopolistic firm. Here we postulate that the precise quantitative impact of advertisement on the level of demand is uncertain and consequently at the time the firm makes the advertising and production decisions, the effect of advertisement is unknown to the firm. Under few general conditions on the demand function, we have been able to rank the optimal levels of advertising and output for the risk averse firm, the risk neutral firm and the firm that faces no uncertainty. Of particular interest is the distinction between the optimal behavior of the risk neutral firm and that of the firm operating under conditions of certainty, which is in contrast with the analysis of Dehez and Jacquemin in particular and much of the traditional firm theory under uncertainty in general. The underlying reason for this distinction in our model is that, unlike in the traditional firm theory under uncertainty, where profit is linear in the random variable, here profit is a concave function in the random variable that captures the demand uncertainty. We have proved, inter alia, that if $1 + \mu > 0$ (where $\mu = h_{22}\frac{z}{h_2}$) and if $\frac{\partial \mu}{\partial z} \leq 0$ then the risk averse firm

advertises less than the risk neutral firm while the risk neutral firm advertises less than the firm operating under certainty. Similarly, if the demand function $h(x, z)$ is additively separable (with $h_{12} = 0$) then the optimal output of the risk averse firm is less than that of the risk neutral firm while the optimal output of the risk neutral firm is less than that of the firm operating under certainty. Finally, we have derived several important comparative static results for the risk neutral firm. We have shown that if the cost of advertising increases the firm reduces the level of advertising and also produces a smaller level of output. As far as the changes in the distribution of the random variable that captures the uncertain impact of advertising on the level of demand are concerned we have shown that a mean preserving spread leads to a reduction in the level of advertising as well as the level of output. Furthermore, if there is an increase in the expected (favorable) impact of advertising on the level of demand, the firm increases its level of advertising as well as the level of output.

APPENDIX

1. *Second Order Conditions.* – The second order conditions for the expected utility maximizing firm are given by

$$\phi_{xx} < 0, \quad \phi_{yy} < 0, \quad \phi_{xx}\phi_{yy} - (\phi_{xy})^2 > 0$$

Where, $\phi_{xx} = Eu''(\pi)[h + xh_1 - c']^2 + Eu'(\pi)[2h_1 + xh_{11} - c'']$

$$\phi_{yy} = Eu''(\pi)[xh_2\alpha - q]^2 + Eu'(\pi)[xh_{22}\alpha^2]$$

$$\phi_{xy} = Eu''(\pi)[xh_2\alpha - q][h + xh_1 - c'] + Eu'[\alpha h_2]$$

The second order conditions for the firm that is operating under no uncertainty are given by:

$$\bar{\pi}_{xx} < 0, \quad \bar{\pi}_{yy} < 0, \quad \bar{\pi}_{xx}\bar{\pi}_{yy} - (\pi_{xy})^2 > 0$$

where $\bar{\pi}_{xx} = 2h_1 + xh_{11} - c''$

$$\bar{\pi}_{yy} = xh_{22}$$

$$\bar{\pi}_{xy} = h_2.$$

2. *Proof of concavity of* αh_2. – To show that, given $(1 + \mu) > 0$ and $\partial\mu/\partial z \leqq 0$, αh_2 is concave in α, first note that,

$$\partial(\alpha h_2)/\partial\alpha = h_2(1 + \mu)$$

and, $\partial^2(\alpha h^2)/\partial\alpha^2 = (1 + \mu)h_{22}y + h_2y\partial(1 + \mu)/\partial z$

The assertion follows immediately, since $h_{22} < 0$.

3. *Comparative static results.* – The second order conditions for the risk neutral firm with additively separable demand function are given by,

$$\phi_{xx} = E[2h_1 + xh_{11} - c''] < 0$$

$$\phi_{yy} = E[xh_{22}\alpha^2] < 0$$

and,

$$D = \begin{vmatrix} \phi_{xx} & \phi_{xy} \\ \phi_{yx} & \phi_{yy} \end{vmatrix} > 0$$

Where, $\phi_{xy} = \phi_{yx} = E[\alpha h_2] > 0$

As for the determination of the signs of ϕ_{xr} and ϕ_{yr} discussed in Section IV, in relation to the comparative static analysis of a mean preserving spread of α, first note that,

$$\partial(\alpha - 1)/\partial\alpha = 1 > 0, \quad \partial h_2/\partial\alpha = h_{22}y < 0$$

Thus, $\text{cov}(h_2, \alpha - 1) < 0$

Consequently, $E[h_2(\alpha - 1)] < Eh_2 E(\alpha - 1) = 0$ (since $E\alpha = 1$)

Hence, $\phi_{xr} = yE[h_2(\alpha - 1)] < 0$

Also, note that, given $h_{22} < 0$, $(1 + \mu) > 0$, and $\partial\mu/\partial z \leqq 0$,

$$\partial h_2(1 + \mu)/\partial\alpha = (1 + \mu)h_{22}y + h_2 y\partial(1 + \mu)/\partial z < 0$$

Thus, $\text{cov}(\alpha - 1, h_2(1 + \mu)) < 0$ (since $\partial(\alpha - 1)/\partial\alpha = 1$)

Consequently, $E[(\alpha - 1)h_2(1 + \mu)] < E(\alpha - 1)Eh_2(1 + \mu) = 0$

Hence, $\phi_{yr} = xE[(\alpha - 1)h_2(1 + \mu)] < 0$

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PUBBLICITÀ IN CONDIZIONI DI INCERTEZZA

In questo articolo si esaminano le decisioni ottime relative a pubblicità e produzione di un'impresa in condizioni di incertezza della domanda. Mentre ci si aspetta che la pubblicità aumenti la domanda del prodotto, l'esatto impatto quantitativo sul livello della domanda è incerto al momento in cui l'impresa prende la decisione di fare pubblicità. Sotto condizioni generali imposte sulla funzione di domanda è stato possibile stabilire i livelli ottimi di pubblicità e produzione per l'impresa avversa al rischio, l'impresa neutrale e l'impresa che opera in condizioni di certezza relativamente all'impatto della pubblicità. Di particolare interesse è la distinzione tra la condotta dell'impresa neutrale al rischio e l'impresa che opera in condizioni di certezza. Vengono qui presentati anche alcuni risultati di statica comparata delle variazioni dei costi pubblicitari e dell'incertezza della domanda.

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PUBBLICITÀ IN CONDIZIONI DI INCERTEZZA

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MULTINATIONAL FIRM RISK AND THE INTERDEPENDENCE OF THE INDUSTRIALIZED ECONOMIES

by
RIAD A. AJAMI *, NECLA V. GEYIKDAGI ** and YASAR M. GEYIKDAGI ***

The majority of United States foreign direct investment lies in the industrialized countries of Western Europe, Canada and Japan. One reason why United States multinational firms invest in other countries is international diversification which tries to reduce risk by spreading operations to several countries instead of simply producing solely in the home country. Levy and Sarnat (1970) explained that an investor could decrease the fluctuations of returns arising from risky investments by holding an internationally diversified portfolio of securities as compared with a domestically diversified portfolio. The same principle can be applied to foreign direct investments as well.

This study attempts to examine the relationship between the systematic risk of United States multinational firms and the economic cycles of the industrialized countries in which these firms are most prone to invest. It could be argued that synchronic economic cycles among the major economies of the world would give multinationals less room for risk reduction through international diversification.

This paper will first attempt to take a sample of United States multinationals and compare their systematic risk averages year by year with those of comparable United States domestic firms. The next step will be to explore the relationship between the multinational-domestic firm risk differences and the Gross Domestic Product growth rates of the major industrialized countries. One could hypothesize that as economic cycles become more

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synchronic between the United States and other industrialized economies, the possibilities of risk reduction through international diversification should decrease for U.S. multinationals and *vice versa*. Thus, the systematic risk or betas of the multinationals should, *ceteris paribus*, increase relative to those of domestic firms which are not directly affected by the opportunities for international diversification.

Given our restriction of 15 percent or less of foreign operations for domestic firms and 35 percent or more for multinationals, a maximum sample of 28 multinationals and 28 domestic corporations was selected from the "Fortune 500" list of U.S. corporations for the 1971-1978 period. In addition, the same but diminished sample of 21 multinational and 11 domestic firms was used for the 1971-90 and 1979-90 periods, and results from the 1971-78 and 1979-90 periods were compared to see if the interdependencies or the interrelationship among the major industrialized economies have indeed increased and, in that case, to examine its impact on the risk of multinational firms. It should be noted that the sample diminished due to mergers and the multinationalization of some of the domestic firms.

Methodology

Total risk, which can be broadly defined as deviations from an expected value, is subdivided into unsystematic risk and systematic risk. Investors can diversify their securities to such an extent that the unsystematic risk, the risk particular to a given security, will be eliminated and the investors will be left with systematic risk, i.e. risk arising from the market as a whole. The beta is a measure of systematic risk or of the sensitivity of a stock's price to overall market fluctuations.

A brief explanation of the steps involved in computing a beta should prove helpful to readers unfamiliar with portfolio analysis. First of all, a holding period rate of return has to be calculated. A holding period rate of return measures the total return investors could have realized had they held the asset during the period being studied (D'Ambrosio, 1976, p. 334). Its formula is

$$r_{hp} = (P_t - P_{t-1} + D_t)/P_{t-1}$$

where r_{hp} is the holding period rate of return; P_t is the ending price for the period in question; P_{t-1} is the beginning price for the period, and D_t is the cash received during that period. The holding period rates of return of both the individual asset and the market index are calculated.

The characteristic line which depicts the relationship between the rate of return on a single asset (the dependent variable) and the rate of return on the market index (the independent variable) is then computed. The characteristic line is an ordinary least square regression line, and the beta is the slope of this line. Thus, the beta indicates the extent to which one can expect a change in the rate of return when the market's predicted rate of return is given. The greater the beta of a particular security the greater its systematic risk.

The betas used in this study are taken from *Value Line Investment Survey* (New York) which started to calculate them in 1971. *Value Line* betas use the New York Stock Exchange Composite Index as the measure of the market index. The individual asset (stock)'s rate of return and the New York Stock Exchange Composite Index rate of return are calculated weekly over a period of five years and the beta is derived using a regression analysis similar to the one explained above.

In this study, any firm which has 35 percent or more of its operations abroad is considered a multinational, while any firm with 15 percent or less of its operations abroad is defined as a domestic firm. A total sample of 56 industrial firms (28 multinationals and 28 domestics) was selected from the *Fortune* list of the largest 500 U.S. firms. This represents all firms which satisfied the above conditions, and is the same sample used in the study carried out by Geyikdagi (1981, 1982 and 1984). The following Standard Industrial Classification (SIC) System industry groups are included in the sample; petroleum refining, electrical machinery, non-electrical machinery,

TABLE 1

NUMBER OF FIRMS IN INDUSTRY GROUPS

Industry Group	SIC Code	Multinational	Domestic
Petroleum Refining	291	3 (2) *	3 (1)
Electrical Machinery	3	3 (2)	3 (2)
Non-electrical Machinery	35	8 (6)	3 (0)
Chemical & Allied Products	28	7 (6)	5 (4)
Fabricated Metal Products	34	2 (2)	5 (1)
Non-ferrous Metals	333	2 (0)	3 (1)
Food Products	20	3 (3)	6 (2)
All Groups		28 (21)	28 (11)

* Numbers in parentheses show the number of firms still remaining during the 1979-1990 period.

chemical and allied products, fabricated metal products, non-ferrous metals and food products. Table 1 shows the number of multinational and domestic firms in each industry group.

As already mentioned, the same study will be carried out for 21 multinationals and 11 domestics for the 1971-90 and 1979-90 periods. The reasons for this decrease in sample size are mergers, acquisitions and growing multinationalization which has increased the foreign content of domestic firms above the 15 percent limit. Clearly, increasing foreign content did not influence the number of multinationals but it did take its toll on the domestics which fell from 28 firms to 11. Still, due to heavy merger activities during the late seventies and the eighties, the multinational sample was reduced from 28 to 21.

We have used a paired-difference test to find statistically significant yearly risk differences between multinational and domestic firms. This method compared pairs of value in small samples using the Student's t distribution technique, and measures the level of significance of the differences. Rather than taking the average of each of the samples we want to compare, we pair a value in one of the two samples with a corresponding value in the other sample according to a common denominator. For instance, the 1972 beta for the multinational firms will be paired with the 1972 beta for the domestic firms, and the same process will be repeated for each year during the period under study. The procedure for calculating the paired-difference test is as follows:

Years	$d_i = B_{Mi} - B_{Di}$
1	d_1
2	d_2
.	.
.	.
n	d_n

where n represents the number of years, d_i represents the difference between the variables which are paired, B_{Mi} stands for the multinational beta average during a given year i, and B_{Di} is the beta average of domestic firms during a given year i.

We let d and S_d stand respectively for the average and the standard deviation of the n difference measurements. If M_d represents the average difference, then

$$H_0 : M_d = 0$$

This means that we want to test the null hypothesis that the average difference is zero. Using the relationship

$$t = \frac{\bar{d} - 0}{S_d/n}$$

we find the Student's t value. For instance, we will use a 95 percent confidence interval or a value of $\alpha = .05$ significance level (.025 for each tail) for the difference and $n - 1$ degrees of freedom. The block design of the paired-difference test increases the amount of information to be obtained. The technique of the paired-difference test has been explained at length by Mendenhall and Reinmuth (1978, pp. 293-97).

This study will also look at the relationship between the year by year multinational-domestic systematic risk (beta) differences and the growth rates of the seven largest industrialized countries. In order to see if these two variables are related, a regression taking the standard deviation of the growth rates as the independent variable and the beta differences as the dependent variable, will be run.

Empirical Results

Figure 1 shows the Capital Asset Pricing Model (CAPM) beta averages for the multinationals and the domestic firms during 1971-78 while Figure 2 indicates the annual percentage changes in the gross domestic products of the seven major industrialized countries from 1969 to 1990.

An examination of Figure 1 shows that the average beta value for the group of multinationals parallels that of the domestic firms until the end of 1973. After that, the two averages diverge, with the multinational betas moving higher in relation to the domestic betas. Thus, we see that systematic risk, which was about the same for both groups until 1973, becomes quite different after that. One explanation of this phenomenon could be the increased degree of interrelationship between the major economies of the world.

Rugman (1979) looks at this issue through the interrelation of world equity markets which became very strong after 1972. Wood and Jianakoplos (1979) examine the annual percentage change of the gross domestic products of the United States, the United Kingdom, Canada, France, Germany, Italy and Japan. As Figure 2 indicates, they found that beginning in 1973, there has been a greater similarity in rates of growth of output among

FIGURE 1. CAPM Betas (28 Multinational vs. 28 Domestic Firms)

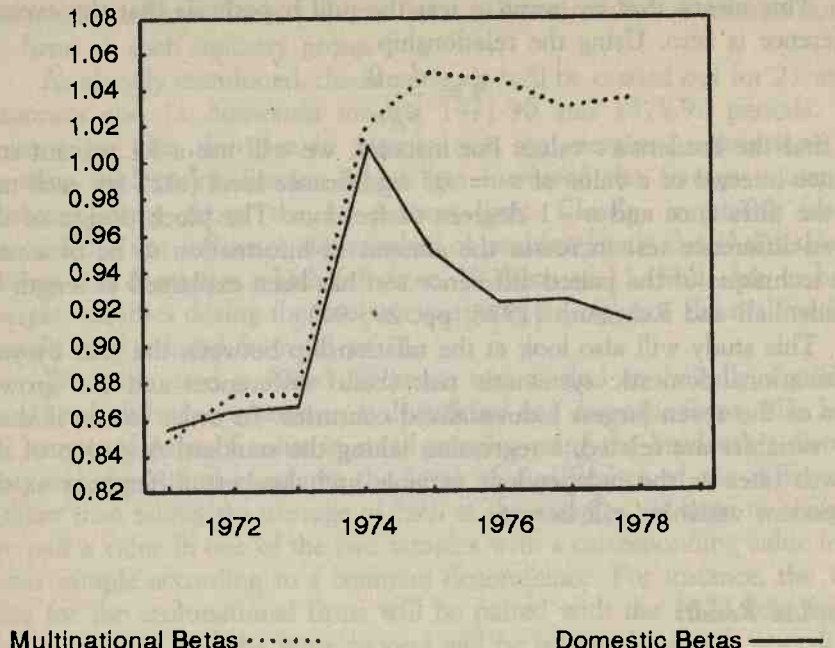
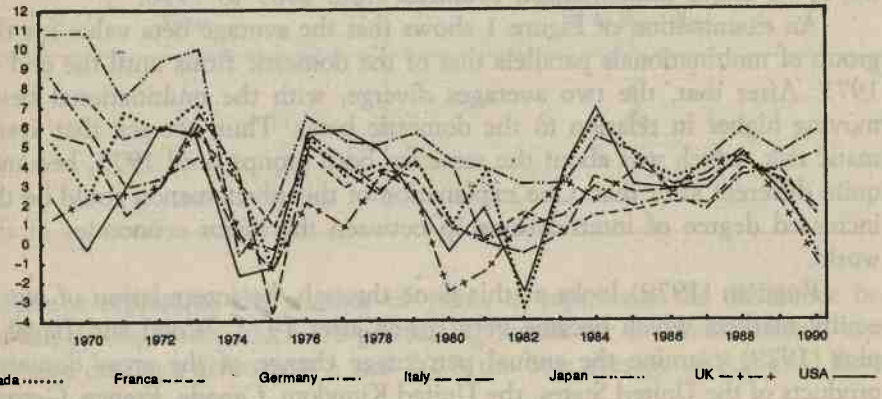


FIGURE 2. Growth Rates of the Countries



SOURCES: THE ECONOMIST INTELLIGENCE UNIT, *Country Reports* (Various Issues).
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the major industrialized countries. One can argue that this left less room for international diversification and hence considerably lessened the opportunities for reducing systematic risk. This is one possible explanation for the increase in the systematic risk of multinational firms relative to domestic firms after the economic recession beginning in 1973.

If there were less covariance between national economies before 1973 than after, then one would expect returns from multinationals to exhibit a lower covariance with the U.S. market index before 1973 than they do afterwards. Since it may be assumed that domestic returns have the same covariance with the U.S. market index before and after 1973, the betas of U.S. multinationals should rise in relation to those of domestic firms after 1973. The formula for calculating the beta value will make this more evident:

$$B = \frac{\text{Covariance } (r_m, r_i)}{\sigma_m^2}$$

where B, r_m, r_i and σ_m^2 respectively denote the beta, the market return, the individual firm's rate of return and the variance of the market returns.

In addition to international diversification, product and export diversifications may also influence risk. However, as Pras (1980) explains, the influence of product diversification on large firms (such as those in our sample) is negligible, while the effect of export diversification is significant. One could argue that export diversification was of greater importance for the domestic firms in our sample since they either had no operations overseas or had them to a much lesser extent than the multinationals. A cursory study, based on the reports of some companies in our sample and supplemented by phone calls for others, seems to indicate that domestic firms were greater exporters than multinationals, especially after 1974.

The results of the paired-difference test are summarized in Table 2. One can see from the t and α values that there is a significant difference between the betas of multinational and domestic firms both as overall groups, as well as within industry sectors. Thus, the difference between the overall multinational and domestic betas as seen in Figure 1 is statistically significant.

The regression between the yearly multinational-domestic beta differences and the corresponding yearly standard deviations of the GDP growth rates of the seven industrialized countries shows a considerable negative relationship with a coefficient of correlation of $-0{,}821$ and a coefficient of determination (R^2) of 0.675. A Durbin-Watson D statistic of 1.602 reveals no significant autocorrelation.

TABLE 2

PAIRED-DIFFERENCE TEST RESULTS

Industry Groups	t value	α
Petroleum Refining	3.186	.02
Electrical Machinery	13.210	.01
Non-electrical Machinery	7.890	.01
Chemical & Allied Products	5.690	.01
Fabricated Metal Products	4.830	.01
Non-ferrous Metals	4.030	.01
Food Products	10.820	.01
All Groups	3.850	.01

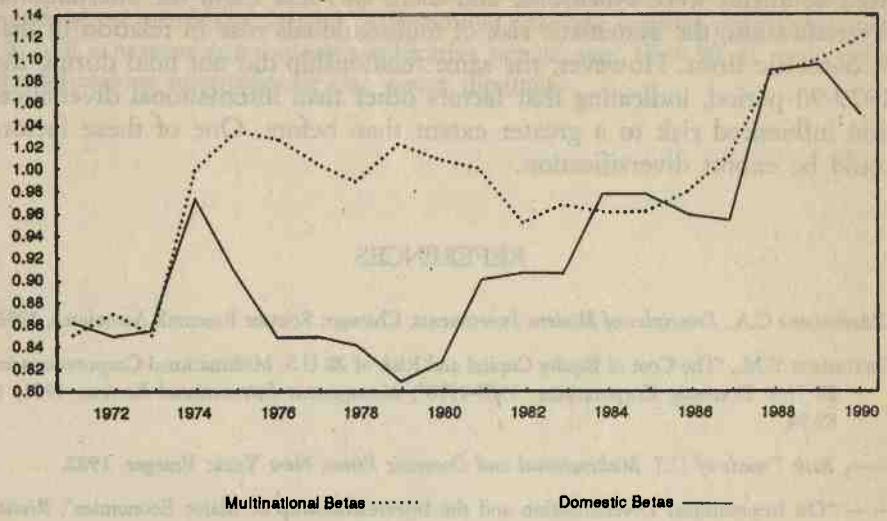
Thus, for 1971-78, the test results support the hypothesis that synchronic economic cycles among the major economies of the world have caused multinational firms to have less opportunities for risk reduction through international diversification. The test shows that as the major world economies began to have similar cycles in 1973, the systematic risk of United States multinational corporations rose in relation to that of United States domestic firms.

As indicated earlier, the study has also been extended to 1990 but, this time, using a sample of only 21 multinationals and 11 domestics. One can observe from Figure 3 that, during 1971-78, the betas for this reduced sample show a similar trend to the full sample betas discussed above. Lower domestic betas continue until 1984 and the difference between multinationals and domestics becomes considerably less after that.

A paired-difference test has also been carried out for the 1971-90 period for all the multinationals vs. all the domestics. The observed t value of 4.9754 and an α value of .01 denotes a highly significant difference at a 99 percent confidence level. Due to the reduction or total disappearance of industry groups in the reduced sample, paired-difference tests were not done separately for them.

The results of the 1971-90 regression between the year by year multinational-domestic beta differences and the standard deviations of the GDP growth rates of the seven industrialized countries show a coefficient of determination of 0.0096 indicating that there is no significant relationship. For 1979-90 the coefficient of determination is also insignificant with a value of 0.0303. A recalculation of the 1971-78 period with the 21 multinationals and 11 domestics sample still yields a coefficient of determination of 0.679 which is very close to the 0.675 that was obtained from the original

FIGURE 3. CAPM Betas (21 Multinational vs. 11 Domestic Firms)



sample of 28 multinationals and 28 domestic firms. Thus, it was not the reduction of the sample size which brought about the different results obtained during the two periods of 1971-78 and 1979-90.

The explanation for this finding may lie in changing patterns of export diversification. The period of stagnation, following the Oil Crisis which began towards the end of 1973, favored the exports of domestic firms over those of multinationals. During the mid 1970s, the rising income in oil producing countries enabled them to import luxury goods and weapons from U.S. domestic firms rather than the standardized products typical of multinational firm exports. This situation seems to have reversed itself during the late 1970s and the 1980s when exports of standardized goods produced by multinationals rose substantially. Thus, the heavier role played by export diversification could have reduced the impact of international diversification. The role of export diversification and its influence on the risk of multinational and domestic firms is outside the scope of this paper and could be a topic for further research.

Conclusions

The results of this study reveal a negative relationship between the systematic risk of multinational firms and international diversification dur-

ing the 1971-78 period. Thus, when the economic cycles of the industrialized countries were synchronic and there was less room for international diversification, the systematic risk of multinationals rose in relation to that of domestic firms. However, the same relationship did not hold during the 1979-90 period, indicating that factors other than international diversification influenced risk to a greater extent than before. One of these factors could be export diversification.

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RISCHIO DELL'IMPRESA MULTINAZIONALE E L'INTERDIPENDENZA DELLE ECONOMIE INDUSTRIALIZZATE

Questo articolo esamina la relazione tra le differenze del rischio sistematico

annuale dell'impresa statunitense nazionale e multinazionale e gli scarti quadratici medi dei tassi di crescita del PIL per i paesi industrializzati. I risultati di una regressione tra queste due variabili indicano una relazione negativa durante gli anni 1971-78 e nessuna correlazione significativa per gli anni 1979-90. Il ruolo della diversificazione internazionale può essere diminuito.

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. . . points, indicating that factors other than multinational diversification influenced risk to a greater extent than before. One of these factors could be country diversification. . . .

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RISCHIO DELL'IMPRESA MULTINAZIONALE E INTERDIPENDENZA DELLE ECONOMIE INDUSTRIALIZZATE

Questo articolo esamina la relazione tra le differenze del rischio sistematico

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A METHODOLOGICAL NOTE ON THE MICROECONOMICS AND MACROECONOMICS OF SAVING

by
BIAGIO BOSSONE *

> "... after all, the actual rates of aggregate saving and spending do not depend on Precaution, Foresight, Calculation, Improvement, Enterprise, Pride or Avarice. Virtue and Vice play no part".
>
> J.M. KEYNES

1. *Micro-macro Inconsistencies and Aggregation Problems in Saving Analysis*

Deaton (1992) brings up the interesting question of the apparent inconsistency between micro and macro empirical evidence to the permanent income hypothesis (PIH). The findings that he reviews point to the fact that, in contrast to the results from the analyses of micro data, tests on aggregate data generally lead to reject the PIH, thereby suggesting that a theoretical gap exists between the microeconomics and the macroeconomics of the PIH, and that such a gap needs to be filled if the detected inconsistency is to be resolved.

The same inconsistency is also noted by Bovenberg (1990) in assessing the performance of optimal intertemporal equilibrium models of resource allocation used to explain aggregate saving behavior. Bovenberg concludes that the latter

"... is understood only imperfectly and remains difficult to model" (p. 7),

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adding that,

> "Modeling and estimating saving behavior is difficult because none of the simple theories is capable of, by itself, explaining aggregate saving behavior" (p. 8).

In fact, both Deaton and Bovenberg observe that a significant number of studies detect an "excess sensitivity" of current consumption to current income at the aggregate level, and recognize that such excess sensitivity does not fit within the predictions of optimal models of intertemporal resource allocation from forward-looking, rational agents, although these models perform rather well at the individual level.

Several reasons have been suggested to give account of the inconsistency. Bovenberg himself hints that many factors may be at play in determining aggregate saving behavior as different households adopt different allocation rules, and as different rules cannot possibly be captured by micro models which, by their very nature, are specifically designed to reflect the behavior of a "representative" agent. Others [1] blame the presence of imperfect capital markets – and of the associated liquidity constraints – as factors that prevent households from fully smoothing their consumption profile over time. Yet others dismiss the intertemporal maximization principle altogether arguing that, in its place, other elements – such as myopia, rules of thumbs and habits – play a dominant role in determining aggregate saving [2]. Furthermore, pointing to the crucial assumptions required for aggregation under the PIH – that is, agents live for ever and possess full knowledge of aggregate variables – Deaton (1992) suggests that relaxing either of the two assumptions generates aggregate models that differ substantially from their micro counterparts and, to show this, submits instructive examples.

A deeper case, however – one that this note will try to develop – seems to rest on the methodological *problem of aggregation*. Deaton himself refers to this problem when he remarks that

> "The aggregation results are ... consistent with a story in which individuals obey to the permanent income hypothesis, but in which aggregation 'problems' cause average behavior not to conform to that of a representative agent" (p. 2).

The purpose of this note is to argue that a fundamental reason for the

[1] See, for instance, HUBBARD and JUDD (1986).

[2] This view is emphasized in CARROLL and SUMMERS (1987).

observed micro/macro inconsistency lies on the analytical structure underlying the neoclassical models of aggregate saving – heretofore referred to as "new-orthodox" models [3] – and on how they deal with the aggregation of individual behaviors. In particular, it shows that simply adding up the behavior of a number of (supposedly) identical agents in a way that neglects their interactions may lead to an incorrect understanding of aggregate saving.

In this connection, the note reconsiders Keynes's theory of aggregate saving, as formulated in the *General Theory* and in subsequent writings (Keynes, 1937a, 1937b), and the role of agents' income interactions therein emphasized. Drawing from Keynes's treatment of aggregate saving, the note suggests that the observed "excess sensitivity" may prove fully consistent with the predictions of the new-orthodox models, provided that these explicitly incorporate agents' interactions.

This note does not claim to provide a general testable model of aggregate saving; it only aims at emphasizing the methodological relevance of agents' interactions for the microeconomic modeling and the understanding of aggregate saving behaviors.

2. *Some Basic Features of the "New-orthodox" Theory of Saving*

Elsewhere (Bossone, 1991) I have dwelled on the theoretical and methodological principles that underpin the common thread linking the "new-orthodox" models of saving to their classical and neoclassical forerunners. In particular, I have suggested that those very features that, on the one hand, make the neoclassical models powerful in explaining individual saving behavior, on the other make them inadequate to explain aggregate saving.

The standard specification of the new-orthodox models of intertemporal resource allocation with no borrowing constraint typically features an *independent* household – representative of many individual and mutually independent households – which, in line with the PIH, maximizes its life-

[3] I have resorted to the term "new-orthodox" in BOSSONE (1991) with reference to the approach to aggregate saving – widely adopted in contemporary literature – using optimal intertemporal equilibrium models of allocation decisions from independent, forward-looking and rational agents (see, among others, AGHEVLI et. al., 1990; BOVENBERG, 1990; DEATON, 1989; and GERSOVITZ, 1988). The new-orthodox approach typically extends the microeconomic optimal decisions framework to the economy as a whole under the assumption that the latter may be treated as a rational agent "representative" of a multitude of identical and mutually independent individuals (see Section 2 below).

time consumption utility subject to an intertemporal budget constraint. Using common notation, the household standard plan is

$$\text{Max } U = E\left[\sum_{t=0}^{\infty} (1+\delta)^{-t} v(c_t)\right] \tag{1}$$

s.t.

$$A_{t+1} = (A_t + y_t - c_t)(1+r)$$

or

$$A_{t+1}(1+r)^{-1} - A_t = s_t \tag{2}$$

where r is the rate of interest on non-human wealth, A, v (.) is a (concave) utility function, s is saving and δ is the rate of time preference [4]. Solving plan (1)-(2) with dynamic programming yields the well known Euler condition

$$\phi(c_t) = E[(1+r)\phi(c_{t+1})/(1+\delta)] \tag{3}$$

where $\phi(c) = v^1(c)$ is the instantaneous marginal utility of consumption at date t. Condition (3) yields optimal values for strategy variables c_t and c_{t+1} – and, accordingly, for s_t and s_{t+1} – which then depend on eqs. (2) and (3) and on the specific time profile of income.

Here, I shall not concern myself with the analytical implications of model (1)-(3); rather, I shall shortly disgress on some of its basic features.

The traditional neoclassical models of aggregate saving [5], as with the theory of real income underlying them, were formulated in ways that maintained: *i*) the mutual independence of *current* income and current saving at the aggregate level, and *ii*) the mutual independence of the agents' saving decisions. Neoclassical theory took current aggregate income to be *predetermined*, or *exogenous*, with respect to current aggregate saving, and denied any relevance to the interactions of individual saving decisions.

The two assumptions were indeed crucial to the theory's implications. They are implicitly embodied in the new-orthodox models of saving and will be seen to lie at the root of the aggregation problem mentioned earlier.

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[4] Note that plan (1)-(2) is equivalent to a plan where the household maximizes (1) subject to the constraint that the present value of its lifetime consumption equals the present value of its lifetime income $\sum_{t=0}^{\infty} c_t (1+r)^t = \sum_{t=0}^{\infty} (1+r)^t$.

[5] I basically refer to the theories of saving as developed by Marshall, Wicksell, Robertson and Ohlin. For an excellent review of these theories, see BLAUG (1985).

Their rationale may be traced to the following, not unrelated, reasons:

> *i*) assuming the current income of the individual household to be exogenous with respect to the household's own current saving decisions, neoclassical theorists deem it methodologically correct to transpose such exogeneity at the aggregate level;
> *ii*) underlying neoclassical theorizing is the presumption of an atomistic, perfectly competitive economic environment where "small" individual agents: *a*) cannot influence the market, know they cannot do so and, thus, take a parametric approach to the information affecting their allocation choices; and *b*) are in a position to supply all the labor they wish at the ongoing wage, thus attaining their desired level of income. From such presumptions follows the irrelevance of interaction effects for the formation of aggregate income;
> *iii*) at the aggregate level, *i*) and *ii*) imply that current income settles at its "natural" (full employment) level, independently of households' current saving decisions.

Working through these assumptions, new-orthodox theory can consistently show that different volumes of aggregate saving may be attained out of any given level of current income – and, indeed, independently of the latter – with each volume being the sum of the individual solutions to the household optimal plans. But if this conclusion is correct at the individual level, it is not so for the economy as a whole. For, as argued by Keynes (see Section 3 below), a correct aggregation of individual actions may not obtain without taking into account the feedback from one agent's action to the others'. The micro/macro inconsistency discussed above may therefore derive from the incomplete extension of micro-models to macro-problems under the flawed assumption that the economy behaves like an individual, or that its behavior can be treated as the sum of its agents' behaviors.

3. *Keynes's Theory of Aggregate Saving*

The aim to capture agents' interactions is what underlies Keynes's theory of aggregate saving and constitutes one of its points of departure from the orthodox tradition. In criticizing the extension of the orthodox assumptions to the study of aggregate saving, Keynes wrote:

> "Though an individual can safely neglect the fact that demand is not a one-sided transaction, it makes nonsense to neglect it when we come to aggregate demand: This is the vital difference between the theory of the

> economic behaviours of the aggregate and the theory of the behaviour of the individual unit, in which we assume that changes in the individual's own demand do not affect his income". (Keynes, 1936, p. 85).

A few pages earlier, Keynes had already pointed to the role of agents' interactions in the determination of aggregate income and saving:

> "The amounts of aggregate income and of aggregate saving are the result of the free choices of individuals whether or not to consume and whether or not to invest; but they are neither of them capable of assuming an *independent* value resulting from a *separate* set of decisions taken irrespective of the decisions concerning consumption and investment". (Keynes, 1936, p. 65. Italics added).

Keynes's theory of aggregate saving develops from the observation that one agent's spending is somebody else's income. This is tantamount to saying that the current income of the household – and, thus, its current saving potential – is affected by the saving decisions of other households; similarly, one's saving decisions affect others' income and saving levels.

> "For although the amount of ... [the individual's] own saving is unlikely to have any significant influence on his own income, the reactions of the amount of his consumption on the incomes of others makes it impossible for all individuals simultaneously to save any given sum. Every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself. It is, of course, just as impossible for the community as a whole to save less than the amount of current investment, since the attempt to do so will necessarily raise incomes to a level at which the sums which individuals choose to save add up to a figure exactly equal to the amount invested". (Keynes, 1936, p. 84).

In other words, in the economic process as represented by Keynes, aggregate saving is only a *passive* variable, and the composition of individual behaviors is such that aggregate saving is brought to equilibrium with investment *mechanically*, through income adjustments [6]. Keynes's central result is that *aggregate saving cannot exceed, nor fall short of*, current aggregate investment or, more precisely, autonomous spending [7]. As Keynes put it

[6] In Keynes's model, the interest rate ceases to provide the saving-investment equilibrium mechanism that it provides in neoclassical theory, and becomes a monetary factor resulting from the interactions of the money supply with the agents' liquidity preference.

[7] In the income formation process as represented by Keynes, once a given amount of money

"... The investment market can become congested through shortage of cash. It can never become congested through shortage of saving. This is the most fundamental of my conclusions within this field". (Keynes, 1937b, p. 222).

4. *New-orthodox Models of Aggregate Saving with, and without, Agents' Interactions*

To assess the effect of incorrect aggregation on saving analysis, consider first the new-orthodox model (1)-(3) of an economy without interactions and then modify the model so as to account for interactions. Through simple steps, the models will show that aggregating individual behaviors without incorporating their interactions: *i*) leads to misinterpret the relationship between current saving and current income at the aggregate level, and *ii*) makes optimal decisions frameworks unable to explain the sensitivity of current saving to current income.

4.1. *The Model without Agents' Interactions.* – The variables used in the model without interactions are marked with the superscript "°", whereas in the model with interactions the same variables will be marked with the superscript "^". Assume a closed economy with two infinitely-lived agents (i, k). If no interactions take place, the model is simply one of two independent agents acting separately and independently, and consuming their own output:

$$y_j^\circ = \hat{y}_j \qquad (j = i, k) \tag{4}$$

$$\hat{y} = c_j^\circ + s_j^\circ \tag{5}$$

$$s_j^\circ = s(r) \qquad s_r > 0 \tag{6}$$

$$\Sigma s_j^\circ = S^\circ(r) = I^\circ(r) \qquad I_r^\circ < 0 \tag{7}$$

$$Y^\circ = \hat{y}_i + \hat{y}_k \tag{8}$$

where y is the agent's income and Y is aggregate income. Identity (4) indicates that income is exogenous. Eq. (6) derives savings as solutions to

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is invested – and until saving equals investment – the money invested becomes available to those who receive it. These may either save it entirely or spend it, depending on their time preferences. If wholly saved, total saving equals investment at once; alternatively, if the money received is partly spent, it increases other agents' income and savings until – when the investment-saving equality is reached – no extra resources are left for additional spending and saving accumulation.

plan (1)-(3) seen above: agents maximize their own lifetime utility subject to the intertemporal budget constraint. Accordingly,

$$A^{\circ}_{jt+1}(1+r)^{-1} - A^{\circ}_{jt} = s^{\circ}_{jt} = w^{\circ}_{jt} - c^{\circ}_{jt} \qquad (j = 1, k) \tag{2b}$$

Thus,

$$c^{\circ}_{j} = \hat{y}_{j} - s^{\circ}_{j} \tag{9}$$

The Euler condition for each agent is

$$\phi_j(\hat{y}_{jt} - s^{\circ}_{jt}) = E[(1+r)\,\phi_j(\hat{y}_{jt+1} - s^{\circ}_{jt+1})/(1+\delta_j)] \tag{3a}$$

Savings flow to the financial market and are employed to finance investments. Eq. (7) expresses the equilibrium interest rate as determined by aggregate saving and investment, where the latter is a negative function of the interest rate.

Note that the model allows for different individual rates of time preference ($\delta_j, j = i, k$). The economy's saving ratio is, thus

$$\sigma^{\circ}_{t} = (s^{\circ}_{it} + s^{\circ}_{kt})/Y^{\circ} \tag{10}$$

4.2. *The Model with Agents' Interactions.* – To represent the case with agents' interactions, the model can be modified by assuming that the consumption of one agent adds to the other's income (in a Keynesian fashion), and by introducing autonomous (exogenous) spending by one agent as the source of another's income. The model now includes three agents with different functions: one shopkeeper-household, i, one worker-household, k, and one firm, f. Firm f produces a consumption good c and employs labor services from household k at wage w_k. Shopkeeper i buys c_i from f, re-sells part of c_i to household k and consumes the rest of her income. She funds her purchases out of the proceeds from her sales to k. Worker k spends (part of) w_k to purchase c_k from i.

In a Keynesian fashion, the process is started by f's initial investment, I, which is assumed to go fully into wage payments to k. No specific assumption is made on f's production function other than its supply fully adjusts to demand. Formally, the model can be described as follows:

$$y'_i = c'_k \tag{11}$$

$$c'_k = y'_k - s'_k \tag{12}$$

$$y'_k = w'_k = I \tag{13}$$

$$I = \hat{I} = \text{BCR} \tag{14}$$

$$y_f = c'_i = (w'_k - s'_k) - s'_i \tag{15}$$

$$s'_j = s'(r) \qquad (j = i, k) \qquad s'_r > 0 \tag{16}$$

$$r = \hat{r} \tag{17}$$

$$y'_f = s_f \tag{18}$$

$$Y' = y'_i + y'_k + y'_f = c'_k + \hat{I} + c'_i \tag{19}$$

Identity (11) defines i's income as k's consumption spending. Eq. (12) represents k's consumption as the difference between k's income and saving; (13) and (14) specify k's wage as the counterpart to autonomous (exogenous) investment spending, $\hat{I}$, by f, financed with short-term bank credit, BCR. Eq. (15) represents f's revenue as i's consumption, that is, the difference between i's income (affected by k's saving) and her saving. As in the model without interactions, individual saving is a function of the interest rate and the latter is given at $\hat{r}$ – eqs. (16) and (17) [8]. According to (18), firm f saves all its current income. Finally, condition (19) sets aggregate income, Y, equal to the sum of the individual aggregate demand components. Note that from (19) follows

$$\hat{I} = Y - c'_k - c'_i = s'_k + s'_i + s_f = S' = \text{BCR} \tag{20}$$

Thus, in equilibrium firm f pays off its bank loan partly with its own saving and partly by borrowing on the financial market the savings therein available. The process can then start again with a new bank loan to f.

As before, households pursue their optimal plans; here, however, after taking account of interactions, the Euler conditions for i and k become respectively

$$\phi_i[(w'_{kt} - s'_{kt}) - s'_{it}] = E[(1+\hat{r})\,\phi_i[(w'_{kt+1} - s'_{kt+1}) - s'_{it+1}]/(1+\delta_i)] \tag{3a}$$

and

$$\phi_k(w'_{kt} - s'_{kt}) = E[(1+\hat{r})\,\phi_k(w'_{kt+1} - s'_{kt+1})/(1+\delta_k)] \tag{3b}$$

where interactions are reflected in the choice of i being affected by k's saving and in the income of f being affected by i's consumption. In order to make the results from the two models comparable, assume that the

[8] Assume that at $\hat{r}$ the supply of bank loans is perfectly elastic.

economy in both cases starts from the same level of aggregate income

$$Y^{\circ} = Y' = Y^{*} \tag{21}$$

and that, at the initial time preferences δ_i and δ_k,

$$S' = s'_i + s'_k + s_f = S^{\circ} = s^{\circ}_i + s^{\circ}_k$$

so that

$$\sigma'_t = (s'_{it} + s'_{kt} + s_{ft})/Y^{*} = (s^{\circ}_{it} + s^{\circ}_{kt})/Y^{*} = \sigma^{\circ}_t \tag{8'}$$

4.3. *Income and the economy's saving ratio.* – Assume a change in δ_k to δ'_k ($> \delta_k$). As condition (3) suggests, in the case without interactions the only effect is an increase in k's current saving and a corresponding increase in the economy's saving at constant output:

$$\sigma^{\circ}_t(\delta'_k) = [s^{\circ}_{it} + s^{\circ}_{ik}(\delta'_k)]/Y^{*} > [s^{\circ}_{it} + s^{\circ}_{kt}(\delta_{kt})]/Y^{*} = \sigma^{\circ}_t(\delta_k) \tag{22}$$

where, for expositional convenience, individual savings and saving ratios are expressed as functions of the rate of time preference (everything else remaining constant).

When interactions are not considered, aggregate saving can change independently of current income and, reciprocally, the latter is unaffected by changes in the former, in line with neoclassical tenets (see Section 2).

In the case with interactions, however, the process does not stop where it was left in the model without interactions, since k's larger saving alters condition (3a): to re-establish equilibrium, agent i dissaves an equal amount of current income [9]. As a result, aggregate saving remains unchanged while current aggregate income declines due to k's lower consumption. In this case, too, the economy's saving ratio increases to

$$\sigma'_t(\delta'_k) = [s'_{it}(\delta'_k) + s'_{kt}(\delta'_k) + s_{ft}]/Y_t \tag{22a}$$

but this time it does so *only* as a result of output dropping to $Y_t < Y^{*}$ [10]. Note in fact that

$$s'_{it}(\delta'_k) + s'_{kt}(\delta'_k) + s_{ft} = s^{\circ}_{it} + ds'_{it}(\delta'_k) + s^{\circ}_{kt} + ds'_{kt}(\delta'_k) + s_{ft} = s^{\circ}_{it} + s^{\circ}_{kt} + s_{ft}$$

[9] The case where i does not dissave is discussed below (see sub Section 4.4).

[10] It may indeed sound surprising that a drop in income causes an increase in the economy's saving ratio. The result is robust, however, considering that in interaction-models – in line with Keynes' multiplier analysis – aggregate income is sensitive to changes in individual saving ratios. This feature will be further discussed below.

that is: aggregate saving has not changed as interactions have set in motion offsetting movements in individual savings, $ds'_{it}(.) = -ds'_{kt}(.)$, and $Y_t = Y^* - ds'_{kt}$, due to the (Keynesian) effect of k's additional saving on income formation.

Alternatively, one can see the effect of a change – say an increase – in the saving of agent i: i's lower consumption decreases both f's income and saving correspondingly; therefore, aggregate saving does not change while aggregate income falls.

These examples show that neglecting interactions hides important inter-agent feedback effects and leads to misinterpret aggregate behaviors. In particular, aggregation without interactions fails to catch the effect of individual, or sectoral, reallocations of saving on aggregate income as well as the retroaction of the latter on the economy's saving and saving ratio: in a closed economy, an increase (decrease) in individual, or sectoral, savings causes downward (upward) income adjustments which neutralize the effect of the initial increase on aggregate saving. The economy's saving ratio increases as a consequence of current income compression.

In the end of the interaction processes sketched above, individual savings are such that

$$s'_{kt} + s'_{it} + s_{ft} = \hat{I} \tag{20a}$$

that is, aggregate saving always equals investment (autonomous spending) [11]. Note that in both examples the adjustment of individual savings – in line with (20a) – to changes in saving behaviors taking place somewhere in the economy occurs in response to agents' optimal allocation decisions (neoclassical adjustment). As will be shown below, the same result holds even if agents behave suboptimally.

4.4. *Saving, investment and the sensitivity of saving to current income.* – The implications of (20a) are the consequence of the fact that the models with interactions are inherently demand-driven, as interactions are induced by acts of spending: once a given level of spending – investment – is exogenously set and money moves from hand to hand the volume of aggregate saving is univocally determined to be equal to investment, independently of individual, or sectoral, saving patterns and of changes in such patterns.

The effect of interactions is such that, in a closed economy:

[11] This implies that there is *always* an amount of saving that the firm can, in principle, borrow long-term to pay off its short-term bank debt, and that, in line with Keynes' conclusion (see end of Section 9), there cannot be a shortage of aggregate saving vis à vis aggregate investment.

i) *changes in saving patterns only determine individual, or sectoral, reallocations of aggregate saving but do not affect its level.*

When resources are injected in a system through exogenous spending (investment), the overall volume of resources left aside at the end of the income formation process (saving) necessarily coincides with the volume of resources initially invested, no matter how agents plan to allocate the income they earn intertemporally (see Section 3 above). As a prove of this, assume that, with I given at $\hat{I}$, k increases her current saving while i does not change hers: c_i falls and both y_f and c_f decrease correspondingly. In this case, s_f absorbs residually the saving behavior of the other agents and is bound to adjust downward enough to offset the change in k's saving: aggregate saving remains constant and equal to $\hat{I}$. (This suggests, for given investments, the existence of an inverse relationship between household and corporate saving);

ii) *changes in aggregate saving can only result from changes in aggregate investment (i.e. autonomous spending) through income adjustments.*

To see this, consider an increase in I'; this translates into an equivalent increase in w_k. If k perceives the increase to be temporary, condition (3b) requires her to save it all; no income change is transmitted to other agents and, in the end, aggregate investment, income and saving all increase by an amount equal to the initial increase in I'. If k perceives the increase to be permanent (i.e., she expects w_{kt+1} to increase by the same amount), she might decide to spend the additional current income and to alter accordingly her intertemporal consumption profile in line with (3b). As an extreme case, assume that k does not change her current and future saving: her higher spending translates into i's higher (present and future) income [12]. If i, too, does not change her saving patterns, the increase in her current and future income goes fully into consumption and y_f and s_f increase correspondingly. In the end, once more, aggregate investment, income and saving increase. Note that, in both circumstances and notwithstanding optimal behaviors, current aggregate saving is sensitive to current aggregate income.

In fact, the distinguishing feature of the interaction-models is the sensitivity of current aggregate saving to current aggregate income that they allow to capture through appropriate aggregation: when investment increases (decreases), its impact on interdependent current incomes leads agents to adjust their savings upward (downward). If this occurs – as it did in the examples above – in response to revised optimal intertemporal

[12] Assume that i foresees correctly k's intertemporal allocation decisions.

decisions (neoclassical adjustment), interaction-models, unlike new-orthodox ones, do show sensitivity to be consistent with optimal behaviors.

Note, however, that sensitivity occurs and (20a) holds even when (some) agents behave suboptimally, i.e., contravene to their Euler rules: in this case, the adjustment prompted by the additional investment is accomplished *residually*, as at least some agents are "forced" by current income changes to adjust their current savings, in a purely Keynesian fashion (Keynesian adjustment): under such kind of adjustment, aggregate income changes until saving is brought into equilibrium with the new investment level. To see this, assume that investment I' drops and that neither k nor i revise their savings: c_t falls by an amount equal to the decrease in I', and y_f and s_f both decrease correspondingly. In this case, although total household saving does not change, s_f adjusts downward residually until s' equals the new I'. As a result, aggregate saving and income move in the same direction and (20a) is satisfied.

4. *Conclusions*

Recent empirical research on saving indicates that aggregate data generally lead to reject the "new-orthodox" models of saving, in contrast with the results from micro-data analyses. A large number of recent studies, in fact, have detected an "excess sensitivity" of current saving to current income at the aggregate level, which cannot be explained by models of optimal intertemporal resource allocation from forward-looking rational agents.

The purpose of this note was to assert the role of aggregation problems in determining the apparent micro/macro inconsistency. Drawing from Keynes's theory of saving, the note has shown that modeling aggregate saving with micro-models that neglect agents' income interactions falls short of providing a correct understanding of aggregate saving behavior. The observed inconsistency may be reconciled with optimal allocation decisions only if agents' interactions are incorporated in the models used.

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NOTA METODOLOGICA SULLA MICROECONOMIA E MACROECONOMIA DEL RISPARMIO

Recenti indagini mostrano che i modelli neoclassici di allocazione intertemporale delle risorse, con agenti « rappresentativi », non spiegano adeguatamente il comportamento del risparmio *aggregato*. Tali risultati appaiono contraddire quelli rivenienti da analisi effettuate su dati microeconomici, le quali sembrano indicare che i predetti modelli riflettono correttamente le decisioni *individuali* di risparmio. Nella presente nota si valuta criticamente la capacità dei modelli microeconomici di spiegare il risparmio aggregato e si sottolinea l'importanza del problema dell'aggregazione nel determinare l'inconsistenza osservata fra il livello di indagine microeconomico e quello macroeconomico. In particolare, traendo spunto dalla teoria del risparmio aggregato tratteggiata da Lord Keynes nella *Teoria Generale* e in scritti successivi e riadattandone il sottostante modello ad un contesto di scelte allocative individuali (ottimali), si sostiene che l'inconsistenza trova origine nell'uso di modelli microeconomici che non tengono conto delle interazioni fra gli agenti e si dimostra che il comportamento del risparmio aggregato può meglio essere spiegato incorporando opportunamente tali interazioni nei modelli adottati.